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The Kansas City Terminal Railway

The railway terminal system of Kansas City, Mo., is extremely complicated and for several years past its facilities have been entirely inadequate for the traffic. This is specially true of the passenger traffic. The city is a great industrial and railway center, and has a population of about 250,000, while the adjacent city of Kansas City, Kan. (which really forms an integral part of this center) has a population of about 100,000.

There are 14 railways entering the city (12 trunk lines and two smaller lines), with connections to the terminal system at its east, west and north sides. For 11 of these lines Kansas City is a terminal, while for the others it is a through station, although changes are made in the composition of nearly all through trains by adding or cutting off cars. The trunk lines are as follows: (1) Atchison, Topeka & Santa Fé Ry.; (2) Burlington System; (3) Chicago & Alton R.R.; (4) Chicago Great Western R.R.; (5) Chicago, Milwaukee & St. Paul Ry.; (6) Rock Island Lines; (7) St. Louis & San Francisco R.R.; (8) Kansas City Southern Ry.; (9) Missouri, Kansas & Texas Ry.; (10) Missouri Pacific Ry.; (11) Union Pacific R.R.; (12) Wabash R.R. The two smaller lines are: (13) Quincy, Omaha & Kansas City R.R.; (14) St Joseph & Grand Island Ry. Of these railways, the Atchison (No. 1), the Rock Island (No. 6), and the Missouri Pacific (No. 10) are through lines, as noted above.

The passenger traffic is served mainly by the present antiquated union station, of dilapidated character and limited accommodation, having only six station tracks. This is used by the ten largest trunk lines, and as several of these have trains arriving and departing at about the same hours there is great congestion of traffic at the station itself and on its approaches. At the present time about 220 trains enter and leave this station during the 24 hours. The other passenger terminal is the Grand Central Station, a dead-end station used by the Kansas City Southern Ry., the Chicago Great Western R.R. and the two smaller lines mentioned. It has two station tracks and there are about 34 trains in and out daily.

The old union station is on the low ground at the west side, close under the high bluffs which limit the city in this direction. The other station is on the top of the low bluffs, close to the Missouri River. The property surroundings and street approaches of this old station are of a very inferior character, and are calculated to give the arriving traveler a distinctly unfavorable impression of the city. There is practically only one street connecting the station with the business section of the city, and that is an indirect route.

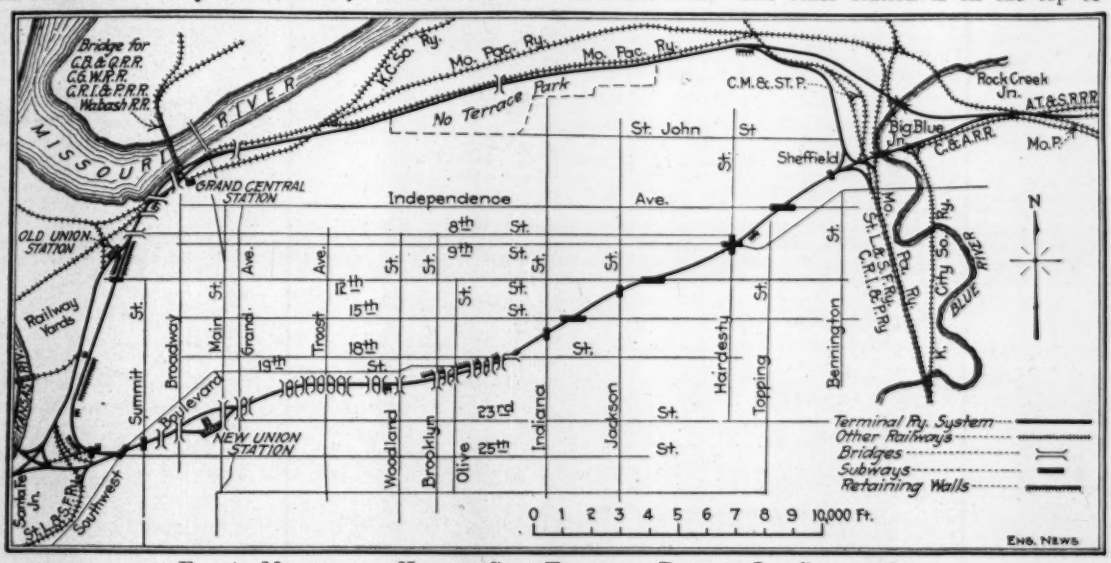

FIG. 1. MAP OF THE KANSAS CITY TERMINAL RY. AND ITS CONNECTIONS

The general situation may be understood readily from Fig. 1. The present railway system of the city forms approximately a long triangle, with various railway connections at each corner. The base lies north and south across the point of land at the junction of the Kansas and Missouri Rivers, and on this base is located the old union station. One side of the triangle extends from the Missouri River along the low land of the northern outskirts of the city, while the other extends from the Kansas River diagonally across the city, the two lines meeting at Rock Creek Junction, just beyond the eastern

city limits. The latter or diagonal line is the old Kansas City Belt Ry.; which was built mainly as an industrial and belt railway, but serves also as the entrance for three trunk railways. As to the freight terminals, these are scattered and have no harmonious or systematic relation. As is usually the case at large cities, each road has located and designed its yards with regard mainly to its own convenience, and the connections between the yards involve a considerable haul for interchange movements.

The New Terminal System

For more than ten years the inadequacy of the Kansas City passenger terminals has been a recognized condition, and in 1905 an investigation was made by engineers representing the various railways with a view to effecting an improvement. Following their report, the Kansas City Terminal Ry. Co. was incorporated in 1906 by representatives of the ten trunk lines using the old union station, for the purpose of building a new station and approaches. The plans adopted were those recommended by the board of engineers, which were substantially the same as the plans now being carried out.

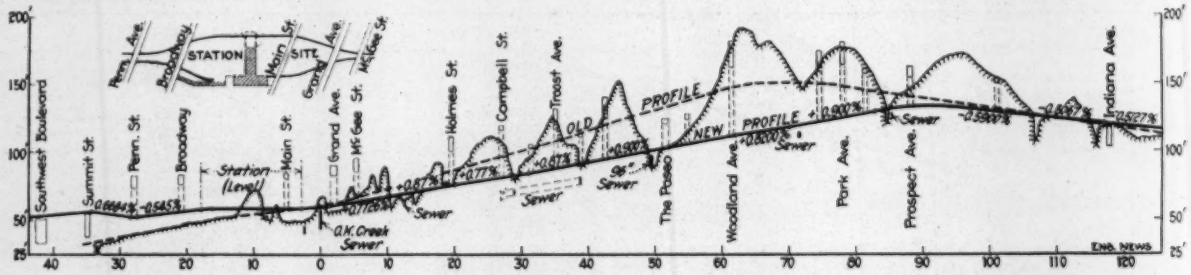

Fig. 2. Profile Showing the Grade Reduction on the Main Passenger Line of the Kansas City Terminal Ry.

The company also acquired control of the Kansas City Union Depot Co. (owning the old station) and the Kansas City Belt Ry. Co., noted above. Negotiations with the city continued for some years, and it was not until September, 1909, that the negotiations were closed satisfactorily, and the company was granted its franchise (for a term of 200 years). Construction was commenced early in 1910, and it is expected that the new terminals will be in operation before the end of 1913. The total cost of the work will be about $40,000,000.

The reconstructed terminal system is shown in Fig. 1, and its special features may be set forth as follows: In the first place, a new union passenger station is established on a new site (on the line of the old Belt Ry.), much better located with regard to its city approaches and its railway connections. In the second place, the old Belt Ry. is converted to a four-track main passenger line through the city and the new station, with a two-track branch to the Missouri River bridge over which railways enter from the north. It will still have to handle some freight traffic as well as industrial business. In the third place, a two-track freight line is to be built around the north side of the city (mainly on an existing right-of-way), so as to keep practically all freight movements clear of the passenger line. The latter will still serve for gathering and collecting local freight, a large number of industries being located along it. It is expected that all the roads entering the city will use the new Union Station.

Auxiliary works include the following: (1) connections with the various railways, which will involve several interlocking plants; (2) two large freight yards, east and west of the city; (3) a double-track bridge over the Kansas River to afford connection with western lines and freight terminals; (4) a freight house, team yard and four auxiliary freight stations; (5) engine facilities for the terminal company's equipment; (6) engine facilities and coach yards serving all the roads using the terminal; (7) alterations to the city streets, sewers and viaducts.

The Kansas City Terminal Co. has an authorized capital of $50,000,000, and its work is expected to represent a total investment of some $40,000,000. The general plan was prepared by the board of engineers mentioned above, and is being carried out subject to various modifications. The design and execution of the work are under the direction of John V. Hanna, Chief Engineer, whose staff is composed as follows: A. C. Everham, Assistant Chief Engineer; C. E. Tebbetts, Bridge Engineer; N. E. Ellis, Signal Engineer; S. O. Swenson, Electrical Engineer; J. Tuthill, Building Engineer; A. H. Stone and G. M. Walker, Jr., Assistant Engineers; and J. M. Hammond, E. P. Weatherley and D. S. McCalman, Division Engineers.

The New Passenger Line

The new main route for passenger trains will extend approximately east and west from the new Union Station, running east across the city for about 6 miles to Rock Creek (the junction with the freight line) and west 1½ miles to the Kansas River bridge, with various railway connections at either end. This line is the old Kansas City Belt Ry. (as noted above), which was built largely to serve various industries. It has a grade of 1.5% ascending eastward for about a mile to a summit between Woodland and Brooklyn Aves., and then descending on another long but easier grade. Through passenger and freight trains required the assistance of a pusher engine on the long grade of 1.5%. It was a double-track line, but as rebuilt it will have ultimate provision for six tracks, although only four will be built at present. The inner tracks will be for passenger service, with one on each side for freight service, the latter connecting with the numerous spurs to industries.

The grade conditions were quite impracticable for a main-line approach to a great terminal station, and one of the heaviest works has been the grade reduction and widening of this line. Fig. 2 shows the old and new profiles, and Fig. 3 shows the work in progress. In planning to lower the grade, however, the sewers formed a controlling limit, as a reduction below this limit would

have involved extensive and costly rearrangement and reconstruction of the city's sewerage system. The lowering at the summit, however, is about 40 ft. From the station the new profile has grades of 0.77 to 0.9% to a summit at Prospect Ave., beyond which it falls by grades of 0.6 to 0.9%, the profile here not varying greatly from that of the original line. The alterations of the profile are such that all street crossings at grade are eliminated, and several streets will now pass over instead of under the tracks, while some of the overhead bridges will be lowered to give better approach grades, as may be seen

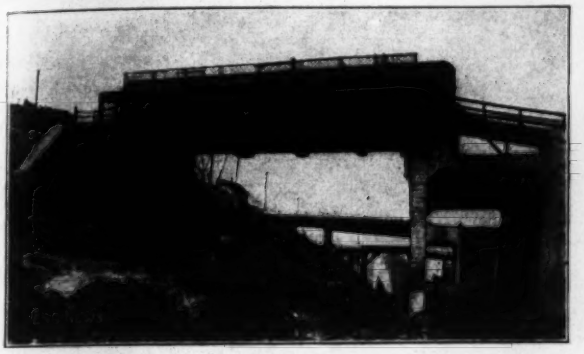

FIG. 3. GRADE REDUCTION ON THE KANSAS CITY TERMINAL RY.

(The concrete box abutments of the bridges are to accommodate inclined spur tracks to industries.)

by Fig. 3. The raising of the grade west of the station will result in carrying Summit St. and Southwest Boulevard under the line by subways, instead of over it by viaducts, as formerly.

The reduction of grade on this busy line has been a difficult piece of work, especially in the long and deep summit cut, where the former depth of 40 ft. has been increased to 80 ft. (Fig. 3). The bottom of the cut was first widened sufficiently to permit of an additional track, for the use of work trains, and the running tracks were shifted laterally from time to time to the lowered grade to allow of excavating the roadbed they had occupied. The cut is largely in rock, but with some clay and shale. The excavated material is used for filling at the station site and yards and at points where the old grade is to be raised.

THE BURLINGTON CONNECTION

This is a new double-track line from the west end of the new passenger line north to a connection with the Burlington R.R. bridge over the Missouri. It parallels the present tracks which extend from the union station to the Kansas River, but while these latter are on the low ground, the new line is being built high up along the face of the bluffs. This involves some very heavy and difficult sidehill work, with long and high retaining walls both to support the line and to support the bluff on the upper side of the line.

Fig. 4 shows a part of the new high-level roadbed and retaining wall. The present low-level tracks will be utilized for the freight line connection from the Kansas River bridge to the new freight line which passes around the north side of the city. The retaining walls are of the reinforced-concrete type.

THE NEW FREIGHT LINE

This line around the north side of the city presents no special features or difficulties, as it is mainly on level ground and follows an existing right-of-way.

SUBWAYS

The subways are of two types, one having a single span over the roadway and the other having a double span with a row of columns in the middle of the roadway. In both cases there are columns at the curb lines. The columns and cross girders are of reinforced-concrete, and the roadway and sidewalk spans are formed by reinforced-concrete girder slabs. The headway is 13 ft. ordinarily, but is increased to 14 ft. 8 in. where electric railway lines pass through the subway. The street approaches where the streets have been depressed to pass under the tracks, are in some cases as steep as 5 or 6%. The typical design and construction of the subways are shown in Figs. 5 and 6, p. 240.

The reinforced-concrete columns are rectangular, with caps 3 ft. square, and sides battering ¼ in. per ft. The reinforcement consists of four vertical angles connected by batten plates, and four anchor bolts are passed through horizontal angles at the base of the column. The columns are spaced 12½ ft. apart, on the line of the street, and carry concrete cross-girders. The inner columns have square caps under these girders, but the end columns have no caps, the end sections of the cross-girders extending flush with these columns and having a bracket at the top. The intermediate sections of the cross-girder, resting on the inner columns, are each 13 ft. long, 2½ ft. wide and 4½ ft. deep. The two end sections are 11 ft. long, 2½ ft. wide and 4 ft. deep. They weigh approximately 13 tons each.

FIG. 4. ROADBED AND RETAINING WALL FOR THE HIGH-LEVEL BURLINGTON CONNECTION; KANSAS CITY TERMINAL RY.

The slab span construction with concrete girder slabs forming the floor, is very similar to that developed by the Chicago, Burlington & Quincy R.R. a few years ago for the subways on its Chicago track elevation work. It has been used also by other Chicago lines for work of this kind. The slabs for the roadway spans are 20 ft. 3 in. long, 6 ft. wide, 31 in. thick at the end over the center columns and 28 in. at the end of the curb columns. The sidewalk slabs are 7 to 15 ft. long, 7 ft. wide and 24 to 33 in. thick. The outer slabs for sidewalk spans are L-shaped, the parapet wall being formed

integral with the slab. In many cases the slabs have to be made for a considerable skew, and a steel plate-girder along each side (incased in concrete) supports the slabs and forms a parapet or facia girder. The weight of each slab is 25 to 35 tons for the roadway span and 5 tons for the sidewalk span.

The girder slabs rest on $\frac{1}{32}$-in. zinc plates on the cross-girders, and all the end or transverse joints are expansion joints, filled with sand mastic. The longitudinal joints between the slabs are closed at the bottom and filled with cement mortar (1:2). The floor (or top of the slabs) is given a waterproof coating, consisting of a primer coat followed by a layer of 5-ply fabric and 1 in. of mastic, which last is protected by a 1-in. covering of limestone screenings. Longitudinal drains of 6-in. vitrified half-tile are laid between the tracks and along each side of the bridge, connecting with lateral tile drains behind the abutments. The stone ballast is at least 5 in. thick under the ties.

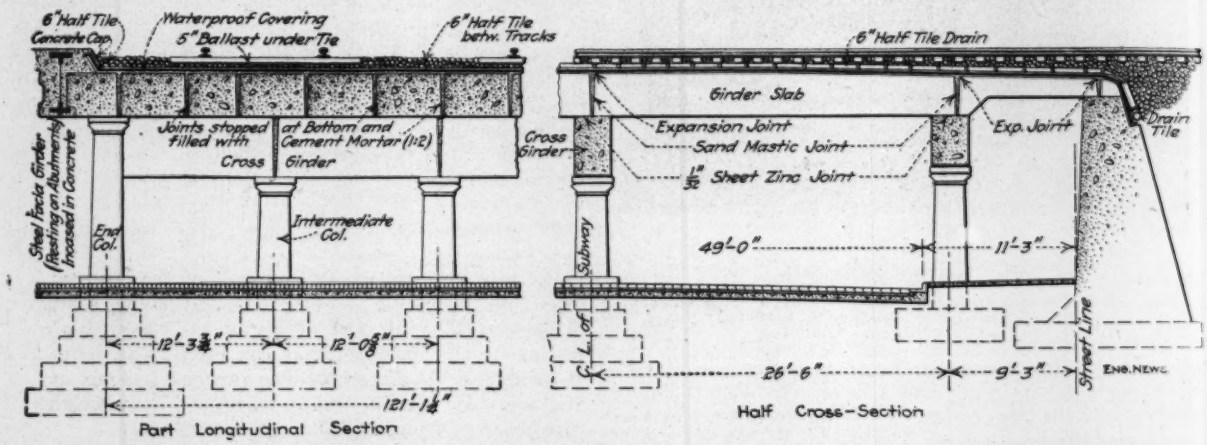

FIG. 5. TYPICAL CONSTRUCTION OF REINFORCED-CONCRETE SUBWAYS ON THE KANSAS CITY TERMINAL RY.

The columns, girders and slabs are all made at a yard at the east end of the work, and in erection they are handled by derrick cars or wrecking cranes, as shown in Fig. 7. This method is more convenient and economical than casting the work in place. In Fig. 8 is shown the column reinforcement assembled ready for use; also one of the steel forms for the end sections of the cross-girders, and a completed parapet slab (skew) for the sidewalk span.

BRIDGES

There are 20 street bridges over the railway on the new passenger line, between the Blue River and the Kansas River, exclusive of three large viaducts across the station yard. There are also nine subways. All the subways are new structures, but some of the bridges are existing structures. These latter will be incased in concrete, the intention being to thus protect all steel work which would otherwise be subject to the corrosive effects of smoke and gas from the engines. Much of this work is being done with the "cement gun."

The existing street bridges over the cut have made middle spans of about 62 ft. carried by steel bents on the side slopes; and end spans of 20 ft. extend from these bents to the abutments. The bents and abutments had to be supported by underpinning as the excavation in the cut progressed. In one case, the pressure of earth forced the toe of an abutment outward, allowing the superstructure to drop into the cut. Nobody was hurt, although a street car had passed a few minutes previously, but considerable trouble was experienced in removing the wreckage. A number of the bridges over this cut have box abutments through which pass the inclined spur tracks leading to industries. This construction is shown at the right in Fig. 3.

The Kansas River bridge has two single-track through-truss spans of 300 ft., with a solid floor or deck of creosoted timber carrying the ordinary ballasted track.

VIADUCTS AT THE PASSENGER STATION

The station proper being south of the station yard, or on the far side from the city, this yard is crossed by three long viaducts carrying the main thoroughfares. These are for Grand and Main Sts., at the east end, and Broadway at the west end. Two of these are new steel-girder bridges with steel bents, all incased in concrete. The Main St. bridge was built a few years ago by a real estate company, but was never opened to traffic.* It has steel arch spans, and the deck is being widened by the addition of columns and cantilever brackets at each side,

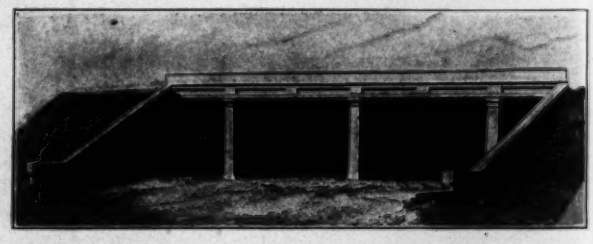

FIG. 6. TYPICAL SUBWAY; KANSAS CITY TERMINAL RY.

a new concrete parapet being built. The bridge will pass directly over the train shed, and at the north end it rises to give a clearance of 22 ft. over the two outer tracks, as these will be used for freight connections and there must be sufficient headway to permit men to stand on top of the cars.

The McGee St. bridge is of interest in having one of

*"Engineering News," Apr. 13, 1911, p. 440.

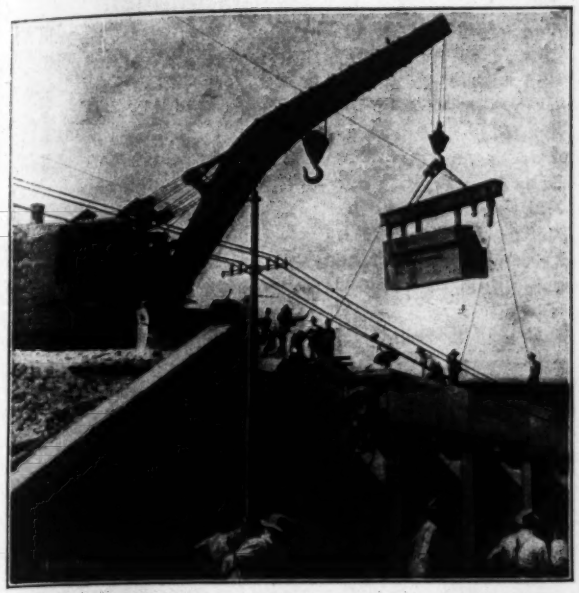

FIG. 7. PLACING THE GIRDER SLABS OF A REINFORCED-CONCRETE SUBWAY

its spans composed of plate-girders 123 ft. long, and also on account of its paving. Creosoted wood-block paving is used, but as the bridge is on a grade of about 5% the blocks are laid with open joints in order to give a foothold for horses. For this purpose a strip of common lath (about 1/8 in. thick) was laid in each transverse joint. The joints were half filled with a pitch composition, and then the upper part was filled to the surface with hot chatts (from the Joplin district), swept into the joints. This pavement has been in use nearly a year and has been found very satisfactory.

THE PASSENGER TERMINAL STATION

This is one of the prominent features of the project, especially in the eyes of the public and the city authorities. The station and station yard extend from McGee St. to Pennsylvania Ave., a distance of about 3600 ft. There is a four-track approach at the east end and a six-track approach at the west end, with two through tracks for freight service passing around the north end of the yard. Fig. 9 is a general plan of the station.

The station will have 16 platform tracks at present, and there is room for eight additional tracks between these and the freight tracks. Crossovers and slip switches provide for connecting any approach track with any platform track, and there will be two very complete power-operated signal and interlocking plants. The platform tracks will be in pairs, spaced alternately 12½ ft. and 31½ ft. When the volume of traffic requires, the tracks of each pair will be connected at the middle of the station by double crossovers. At either end are stub tracks for mail and express cars. As different railways approach at opposite ends, the station will be operated as a double-end station, each platform track being long enough for two trains, so that the train capacity will be 32 trains (or 48 when the additional tracks are laid). The platforms are 21½ ft. wide, and 1400 ft. long. The present traffic will be about 300 trains daily.

Baggage, express and mail will be handled on electric trucks. Under each end of the station is a subway for trucking, with elevators to each platform. Nearly 10,000 pieces of baggage and 350 tons of mail will be handled daily, and much of this is through matter that has to be transferred from one road to another. Thus, in addition to handling mail and baggage in and out of the station, there will be a heavy transfer movement through the station. In general, it is planned to handle baggage at the west end and mail at the east end of the station, but as different roads enter from opposite ends and many trains have combination cars, this arrangement cannot be followed rigidly.

The new station is much more favorably situated than the old station in regard to connection with the city, there being at least four parallel and wide main streets extending in a straight line between the station and the business center. The new location, however, will necessitate extensive changes in the street-car lines and routes. The plaza in front of the station will be connected with the boulevard system of the city. The terminal company has also purchased about four blocks of land to the south of the plaza and has deeded this to the city for use as a park, so that the station cannot be surrounded by buildings, and will always have an attractive setting, which is of quite as much importance as the intrinsic architectural features of the building.

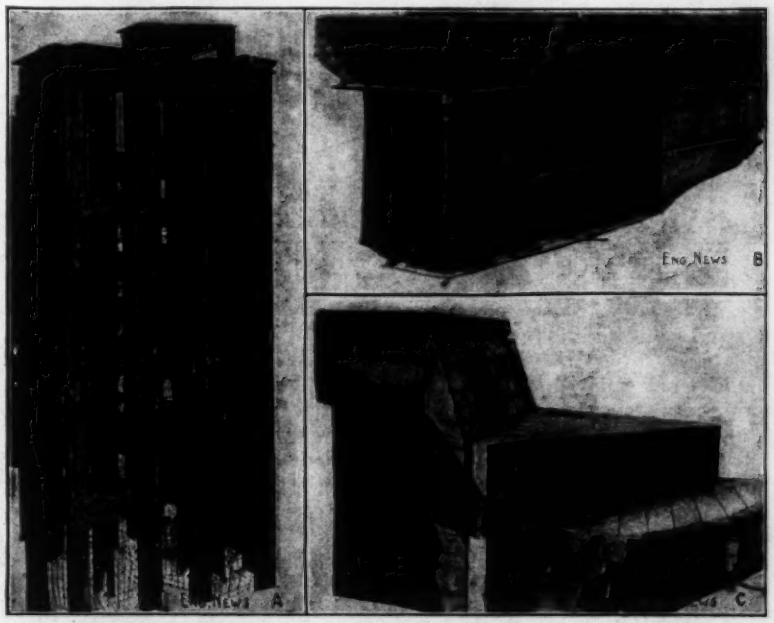

FIG. 8. MEMBERS FOR REINFORCED-CONCRETE SUBWAY

A, Reinforcement for columns. B, Form for end portion of cross girder. C, Completed sidewalk slab, with parapet.

Station Buildings and Trainshed

The station building is on the south side of the tracks, or the side farthest from the city (as already explained) and fronts toward the south. The approach from the city, therefore, is over the bridges which span the passenger yards, and then into a broad plaza in front of the station. The architect for the station is Jarvis Hunt, of Chicago. The building is of Indiana limestone, 500x150 ft. in plan, and two stories high, or four stories from the track level. The first or main floor is at the plaza level, and the entrance opens into a spacious hall, called the grand lobby. This is about 100x230 ft., with a height of 90 ft. Around this are arranged the ticket office, baggage checking office, telegraph and cab office, dining and lunch rooms, news-stand, etc. The carriage yard, with canopy roof, is at one end of the building. On the upper floors are located the terminal company's offices, as well as offices for tenants whose business is connected with the railways using the station.

Fig. 10 is a general view of the main front, with the large arches over the entrances. The steel framing at the street level (in front of the building) will support the pavement over the driveway on the track level below. Fig. 11 is an end view of the main building, with the waiting-room structure extending across the station tracks. The space in front of this will be covered with the trainshed. At the right is the roof of the long row of express buildings. To the right of this again is the depressed roadway, with steel framing being erected to carry the carriage drive at the main street level (approximately level with the roof of the express building).

On the floor below the main floor are the baggage room and mail rooms, on the same level with the tracks, 23 ft. beneath the street. The tracks are arranged as stub sidings for mail and baggage cars. This level is made accessible for wagons by inclined roadways from the plaza level.

The special accommodations include rest rooms for women and children who have to wait some time for train connections; an emergency hospital, an isolation room for confining prisoners or persons having contagious diseases, a basket-lunch room for persons having their own lunch (no eating being allowed in the waiting room), and a large waiting room for emigrants, large numbers of whom pass through this city. Adjacent to the basket-lunch room and emigrant room will be a lunch counter serving coffee and light refreshments, independent of the regular lunch room.

An unusual feature of the station plan is that the waiting room is in a separate one-story building at right angles to the main building (Figs. 9 and 11). It is at the main floor or plaza level, and extends across the station tracks for the entire width of the trainshed. This building is 165x422 ft., with the emigrant room and lunch room at the farther end. The main waiting room is 77x350 ft., and 60 ft. high to the flat roof; it has seating accommodations for 750 persons. This room occupies the middle portion of the building and is flanked on each side by a corridor 40 ft. wide which opens into the central hall or grand lobby of the main building. These corridors are finished in gray brick, and have suspended plaster ceilings with pipe space above.

In each corridor are stairways and elevators to each platform, and along each side of the waiting room there is a doorway and ticket inspector's booth for each platform. This duplicate arrangement is necessitated by the fact that as the station is operated as a double-end station, there may be two trains standing on the same platform track, headed to go out in opposite directions. Passengers going to the trains will pass through the waiting room, show their tickets at the proper gate, and pass out to the corridor to descend by the stairs or elevator to the corresponding platform. Incoming passengers will ascend to the corridors and pass along these directly to the main building, without entering the waiting room. It is proposed to experiment with escalators also to bring these incoming passengers from the platforms up to the corridors.

To the west of the station is a long row of two-story buildings for the express companies. These are at the track level, and are inconspicuous from the plaza. They are approached by inclined roadways. Behind them is the power house, with equipment for supplying light, heat, water, ventilation, etc., throughout the station and for the coach yard and engine terminals.

The trainshed will be of the low-roof Bush type, with a reinforced-concrete roof having spans of 44 ft., supported by rows of columns on the platforms. Special attention will be given to securing good light by means of ample skylight area, as some trainsheds of this type are very insufficiently lighted (even in bright weather) when trains obstruct the general diffusion of light. The

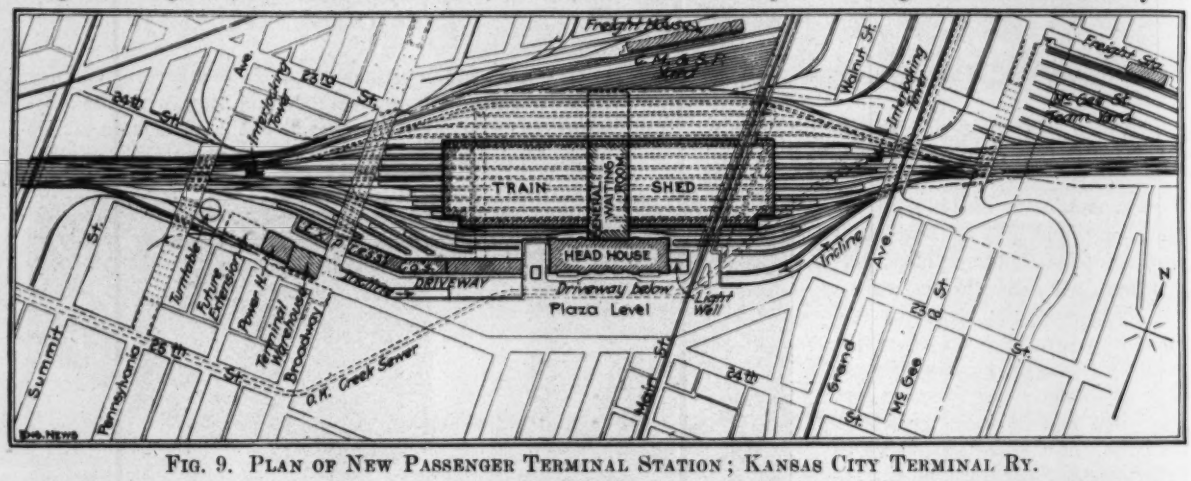

Fig. 9. Plan of New Passenger Terminal Station; Kansas City Terminal Ry.

trainshed will be 1400 ft. long and 340 ft. wide. The width will be increased to cover the eight additional passenger tracks when these tracks are built. The clear height to the roof will be 11 ft. above the center of the platforms, and 18 ft. (above the rails) at the center of the spans.

Engine Terminals and Coach Yards

The terminal company will do all switching and making up of trains with its own engines, and will do all cleaning of cars and road engines. The engine facilities and coach yards will be located at the west end of the line, beyond Southwest Boulevard, a short distance from the station. At the present time the individual roads lose much time of their road-engine service by these engines having to make long runs between the passenger station and the outlying engine terminals. In some cases this run (including switching) occupies about an hour, which is included, of course, in the crew's time. For incoming trains, the road engine will be cut off at the station and sent to the roundhouse, leaving the train to be handled by switching engines. For outgoing trains, the switching engines will place the train in the station, ready for the road engines to be coupled on.

Fig. 10. Main Front of New Passenger Station; Kansas City, Mo.

For the switching work, the company has 30 six-wheel 78-ton engines and two eight-wheel 93-ton engines. These use oil fuel, which is specially advantageous for service of this kind, as it eliminates the loss of time in having to run to the cinder pit and clean fires at intervals. The fuel cost is about the same as with coal, and the cost for boiler repairs is a little higher (due to the effect of the high temperature on the firebox). In view of the ousting of the Standard Oil Co. from Missouri, it is thought likely that coal will have to be substituted in the near future. These engines are cared for at a rectangular engine house at the Armourdale yard (west of the Kansas River). This has six tracks with capacity for two engines each.

For the road locomotives, there will be a 53-stall roundhouse, served by a 90-ft. turntable. Probably this building will be of brick, with wood roof trusses. The terminal forces will attend to the work of cleaning and building fires, supplying fuel, water and sand, and generally putting the engines in condition for road service. The coach yard will be specially equipped for efficient and economical car-cleaning work. The yard will be well ballasted and drained, so as to avoid the ill-kept appearance of many yards of this kind. These facilities will be sufficient for handling about 90 locomotives and 400 cars daily.

Freight Yards

Two freight yards will be provided, one east and one west of the city, for the interchange of through cars between the several roads, and also for handling cars for local industries.

Armourdale Yard—This is the smaller of the two yards, and is at the west end of the line, west of the Kansas River. It is already completed and in operation. It has 24 classification tracks, with capacity for 1000 cars, and from 700 to 1000 cars are handled daily. When transfers from other lines arrive in this yard, the cars are sorted or classified, and distributed to the various industries. The cars from the industry tracks are collected also and assembled in the yard ready for delivery to the different roads.

There are two notable features in this yard. In the first place it is ballasted, drained and kept in first-class condition. This gives it a decidedly unusual appearance, but one which undoubtedly suggests efficiency and economy of operation and maintenance. In the second place it has a track scale of 150-tons capacity and of very substantial construction, built to the specifications of the Baltimore & Ohio R.R. The dead rails are carried by transverse I-beams, while the live rails are supported by pedestals between the beams and resting on the girder of the weighing mechanism. The deck is stationary, and is made waterproof as far as possible. The concrete pit is well drained and this pit is also made unusually high and is lighted by electric lamps so as to facilitate the work of inspection of the mechanism. No cars are weighed while in motion, but each car is cut loose and is brought to a stop on the deck before the scale mechanism is thrown into operation. No recording device is used on the scale at present.

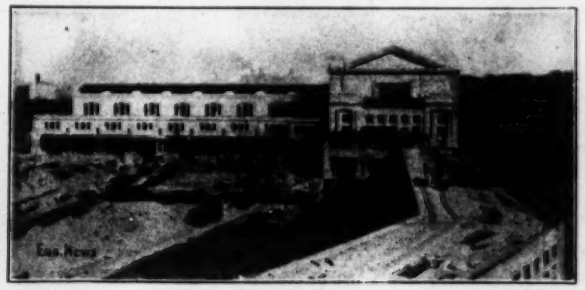

Fig. 11. End View of New Passenger Station
(The waiting room is in the structure spanning the tracks. At the right is the top of the express building.)

Blue River Yard—This is at the east end of the terminal line, and east of the Big Blue River. It will be considerably larger than the Armourdale yard. The grading for this yard is now being done, and it will have capacity for about 2000 cars on the classification tracks. The switching will be done by shifting engines and not by gravity.

Team Yard—Just beyond the McGee St. bridge and on the north side of the main tracks is a team yard and freight station, with capacity for about 300 cars. This has three house tracks and eight pair of stub tracks 200 ft. to 1000 ft. long. These tracks are spaced alternately 12½ ft. and 40 ft. between centers, and between the pairs of tracks are brick-paved driveways 30 ft. wide between curbs. The equipment includes a 10-ton wagon

scale, and a platform with incline approach for loading automobiles, traction engines and farm machinery. The freight station is a two-story concrete and brick structure, 56x175 ft., with platforms extending the full length of the house tracks.

An interesting feature of this team yard is the use of concrete bumping blocks at the ends of the tracks, each being faced with a wood striking block having car springs placed between this and the concrete. The footing of the concrete block extends under the rails, so that the weight of the car is on it when the coupler comes in contact with the block. Although the weight of the block is about 16 tons it is not sufficiently stable to resist shocks, and already one of the bumpers has been tilted out of position by cars striking it.

Besides handling the local freight distribution, the terminal company is required (by its franchise) to establish four freight sub-stations for receiving and delivering less-than-carload lots which will be transferred between these points and the main freight stations of the trunk lines. Carload lots will be handled also at these points, for the convenience of shippers and merchants.

FIG. 12. FALSEWORK USED IN THE ERECTION OF THE STATION BUILDING: KANSAS CITY TERMINAL RY.

THE O-K CREEK SEWER

The site of the station was crossed by the winding course of the O-K Creek, which was used as an outfall sewer. This has been diverted to a concrete conduit some 6000 ft. in length (Fig. 9), part of its length having two chambers about 15 ft. high and 15 ft. wide. Part o fthis has an arched roof and part has a flat slab roof. Most of the work was built in open cut, but for a distance of 1230 ft. it is in tunnel, lined with concrete by the pneumatic process. This diversion work (shown on the plan, Fig. 9) cost about $930,000. The tunnel was described in our last week's issue.

CONSTRUCTION WORK

Most of the excavation and grading is done by the terminal company with its own forces. This policy was adopted on account of the greater facility of handling the work trains without interfering with traffic. The equipment includes a number of steam shovels, and the material is handled partly by large side-dump cars and partly on flat cars with power-operated unloader plows. The concrete work is all done by contractors, one of whom has a special yard for casting the columns, slabs, etc., used at the subways, as described already. Stone for concrete and ballast is obtained from the bluffs near the eastern end of the line, at Rock Creek, where a crushing and screening plant is located. The contractor for the station building (George A. Fuller Construction Co.) uses at that point a portable concrete mixing plant, consisting of a flat car equipped with engine, mixer and hoppers. The mixer is at the end of the car and discharges directly into barrows or carts. Much of the concrete for the buildings was distributed by spouts and chutes from elevator towers.

In the construction of the main building of the station, an interesting system of falsework was used, consisting of a heavily braced timber structure which served for all the erection and finishing work. This is shown in Fig. 12. The structure had to be heavy enough to carry the cranes used in handling the steel and stone work, and remained in use afterwards for the use of the various contractors for the interior work.

The bridges and subways, buildings, etc., were done under various individual contracts by numerous contractors.

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A Public Service Commission of five members superseded the old Massachusetts Railroad Commission of three members on July 1. The new Commission has considerably enlarged powers over railroads and to it are transferred the control of telegraph and telephone companies, formerly exercised by the State Highway Commission. The new Commission will also have control of express-company service. The members of the newly constituted Commission will, after a preliminary period of readjustment, serve for terms of five years each. The president will be paid $8500, the other four members $8000 each per year for their services. The Commission, under the terms of the Act, is given "general supervision and regulation of, and jurisdiction and control over, all persons, corporations," etc., who are acting in the state as common carriers for the transportation of persons or property, or both, by railroads, street railways, electric railroads, and steamships, including express service. The term "common carrier" is also interpreted to include persons or corporations engaged in the transmission of intelligence by electricity. The Commission is given power to inquire into the "rates, charges, regulations, practices, equipments and services of common carriers," operating in the state "and elsewhere, rendering any service of the kind subject to its jurisdiction," and it may prescribe rates and charges. If it deems advisable, the Commission may cause the "accounts of any common carrier or class of carriers" to be audited annually. It may also prescribe systems of accounting for the common carriers of the state. Power "to determine the fair value for any purpose of all the property of any common carrier rendering public service, subject to the supervision of the Commission," is given to the Commission, and also power of revaluation. The Act limits the "bonds, notes or other evidences of indebtedness, issued by any railroad corporation to twice the paid-in capital stock of the company. Under the Act it becomes unlawful for any railroad company to issue "bonds, coupon notes or other evidences of indebtedness payable at periods of more than 12 months from the dates thereof, unless the same are authorized by a vote of the stockholders at a meeting called for the purpose, and unless the proposed issue has been determined by the Public Service Commission to be a proper and reasonable one for the purpose set forth in the application for approval, made by the company proposing to issue the evidences of its indebtedness." All the rulings or orders of the Commission are subject to review in equity by the Supreme Judicial Court of the State of Massachusetts, with power to "annul, modify or amend," but only insofar as the rulings or orders are unlawful. The Act also provides that the Supreme Judicial Court of the state shall have jurisdiction upon the application of the Commission for the enforcement of orders of the Commission, and permits the Commission, through its Counsel, but under the supervision of the Attorney General, to begin action to enforce any of the orders of the Commission. Members of the Commission are:

Frederick J. Macleod (Chairman), Cambridge, for five years.
George W. Anderson, Boston, for four years.
George P. Lawrence, North Adams, for three years.
Clinton White, Melrose, for two years.
George W. Bishop, Newtonville, for one year.

How To Build and Improve Seaside Resorts*

By John S. Brodie†

It has been only during the last hundred years or so, and coincident with the growing popular interest in hygiene, that towns have been planned and built in close proximity to the sea, for health and recreative purposes only, and not in any degree for commercial uses. Blackpool, Bournemouth, Brighton, Clacton, Eastbourne, Southend, and other similar towns are examples, and it is of such towns, rather than of those other seaside towns which have commenced their careers from a business aspect, such as a navigable channel or a safe harbor, used primarily as a sea outlet for inland produce and other business purposes, and have developed, or tried to develop, a visitors' quarter, that the author wishes to devote this short paper to.

HYGIENIC AND RAILWAY ADVANTAGES—The first and most valuable asset to a seaside town, then, is the sea breeze, and all plans made to lay out such a town should keep this first requisite of success always in view. The second essential condition for a City Beautiful by the sea is a pure and plentiful water supply in constant service. The third condition is first-class railway facilities between the seaside town and the great centers of population. The fourth is low rates.

POLLUTION OF AIR—All posible efforts should be made to prevent any pollution of the pure sea breezes. No smoke nuisance should, if preventable, be permitted, and only then such buildings as are absolutely necessary, such as gas, electricity, refuse destructor, and similar works, which should be placed in such a position on the outskirts of the town that the prevailing winds will carry their fumes away.

STREETS AND PROMENADES—The streets should be laid out of extra width (in no case less than 100 ft. between front main building lines) to those in a commercial town, and trees should be planted therein wherever it is possible to grow them, while flower beds should be laid out in every available plot of space or waste land, so that the eye can be rested by way of change from seascape and road surfaces. The paving of the streets should be noiseless, impervious, and pleasing in appearance, and the streets should be kept perfectly clean, even if they have to be swept and watered every half-hour.

STREET LIGHTING—All much-frequented thoroughfares should be lighted at least to the "Newspaper" standard, as a minimum; that is, it should be possible for any person of ordinarily good eyesight to be able to read a newspaper easily and comfortably continuously as he walks along the street.

DRAINAGE—The sewer should be well planned, laid, and ventilated, and the sewage should beadequately treated before being discharged into the sea in deep water, at a properly selected point, so that it can always be relied upon to be carried out to sea by the tidal currents.

PUBLIC SEATS—Seating accommodation, on as large a scale as possible, sufficient for at least 10% of the maximum visiting population, quite free from any irritating charges, should be provided for weary pedestrians to rest themselves and enjoy the beautiful breezes and sunshine to the fullest extent.

SHELTERS—Shelters, for refuge during inclement weather, should be provided in abundance, and also free of charge.

CONVENIENCES—Public sanitary conveniences, often conspicuous only by their absence, should be provided wherever possible, in easily accessible but unobtrusive positions, and at the minimum charges (if any).

SEA-WATER SUPPLY—Every seaside health resort should have its own sea-water supply works, with a regularly planned network of distributing mains, so that it may be practicable for every hotel, boarding, and ordinary dwelling-house to have, at a comparatively small cost, its own sea-water supply laid on for bathing purposes, properly filtered.

PUBLIC BATHS—Covered-in and open-air sea and fresh water swimming and other baths should also be provided, so that the utmost advantage can be taken of the bountiful and health-giving sea.

SURF BATHING—There is nothing in which, as it appears to me, there is a greater scope for improvement than in the facilities now available for sea or surf bathing. Some arrangement which shall be sanitary, safe, convenient, and cheap, is very much required in connection with surf-bathing. It is distinctly an adverse reflection upon those responsible that sea-bathing fatalities are still possible in a well regulated resort. In no case should bathing be allowed unless a rescue boat is in attendance, properly manned with a reliable crew.

SANDS—The sands and foreshore, whether they are extensive, should be kept and maintained in a perfectly clean condition, and, where not washed by every tide, they should be scavenged and cleansed as regularly as the streets.

*A portion of a paper read at a Conference held by the Institution of Municipal and County Engineers, at Great Yarmouth, England, July, 1913.

†Borough Engineer, Blackpool.

A Phenomenally Heavy Rain in Illinois in 1912*

During the summer half-year local thunderstorms accompanied by rainfall of several inches occur frequently enough to cause no more than passing comment, and doubtless there is no locality to the east of the Rockies that has not a record of a rain of 4 or 5 in. in less than 24 hr., which is popularly referred to as a "cloud-burst." While 24-hr. rains of 4, 5 or even 6 in. probably have fallen once or twice in many sections of the central part of the country in the last 30 or 40 years, when the fall gets much above 6 in. it should have a place in the list of very unusual phenomena. At Alton, Ill., there was a rain during the night of July 13-14, 1912, that is believed to be unprecedented in the middle Mississippi Valley.

July 13 was seasonably hot. Light rain began about 11 p.m. The heavy rain fell from 12:50 to 4 a.m., and more than 9.22 in. fell in the entire storm. There is no rain gage in Alton, but several empty buckets and jars that had been left in places favorable for the measurement of rainfall were filled. After applying the formula to ascertain the rainfall value of the contents of these vessels it was found that the deepest contained 9.22 in. At the Equitable Powder Co. plant in East Alton a rain gage had been established on account of a lawsuit involving rainfall. This is five miles east of the main point of destruction, and the rainfall was not so heavy as in Alton proper. On account of the flood no reading of the gage could be made until 2 p.m., Monday, July 15. The gage then showed 5.60 in., and it was estimated that allowing for evaporation the rainfall was about 6.50 in.

The damage done by water was greatly augmented by the topography, as Alton is a very hilly place. Belle St., the scene of the greatest havoc, lies between two precipitous hills, and its extremity farthest from the river is steep. At 12th and Belle Sts. the water was over the curbstones at 1:15 a.m. After this the rate of rise is problematical, but mud-lines on houses in Belle St. below the steep portion of the thoroughfare, show that at some time the torrent was 7 ft. deep. In the principal business portion of the city the water was 2 or 3 ft. deep.

A 7-ft. masonry sewer in Belle St. gave way in several places under the hydrostatic pressure and the street was washed out to a depth of 20 ft. This sewer gave way under the Alton gas-works and a portion of the plant was wrecked. Small houses were washed away and in numerous houses the mud was several inches deep on the first floor. Four persons were drowned by being caught in low-ceiled rooms. In some of the other streets paving bricks and macadam were washed out and the street bed eroded several feet.

The storm was severest at Alton, but was very heavy along the river, particularly on the east side, from slightly above Alton to a short distance below St. Louis. In St. Louis, rain fell from 2:32 to 4.52 a.m.; the total amount was 3.16 in., of which 2.95 in. fell in one hour. This is the heaviest rainfall for one hour ever recorded in St. Louis, the nearest approach to it was in 1873, when 2.93 in. fell in one hour on June 9. Other places not far from East St. Louis and Alton had precitation as follows: Hillsboro, no rain, but severe electrical storm; Edwardsville, 6 in.; Mascoutah, 0.20 in.; Waterloo, trace; Carlyle, 1.55 in.

*From a report by M. W. Hayes, U. S. Weather Bureau, St. Louis, Mo., published in the 1913 "Proceedings" of the Illinois Society of Engineers and Surveyors.

An Average Rainfall of a little over 1 in. per day on the Island of Maui, one of the Hawaiian group, is reported in Water Supply Paper No. 318, of the U. S. Geological Survey, which has just been issued. The paper deals with "Water Resources of Hawaii, 1909-11."

The greatest amount of rainfall observed at any station was at Waikamoi mauka, on the windward slope of East Maui, where the total precipitation from the time the station was established, Oct. 12, 1910, to Dec. 31, 1911, was 455.78 in., an average of slightly over 1 in. a day for the entire period. In comparison with this, the 13.01 in. of rainfall during 1911 and 11.28 in. during 1910 at the Hawaiian Commercial & Sugar Co.'s camp No. 7, show the decidedly arid conditions prevailing on some parts of the island.

The Effect of Proposed Storage Reservoirs on Stream Flow and Water Power on the Lower Chippewa River, Wisconsin

By Clinton B. Stewart*

The Chippewa River has a drainage area of about 9600 sq.mi. in northwestern Wisconsin, extending from the Wisconsin-Michigan state line, near Lake Superior, to the Mississippi River which borders the state on the west.

The river has a total fall of approximately 835 ft., of which about 290 ft. may be considered as feasible at the present time for water-power development. The river also has an important tributary, the Flambeau, with a drainage area of 1960 sq.mi. and a total fall of about 537 ft., of which about 184 ft. may be considered as feasible for water-power development. The total fall feasible for water-power development, on the main river with this tributary, amounts therefore to about 474 ft. About 240 ft. of this fall has already been developed, or is in process of development at the present time.

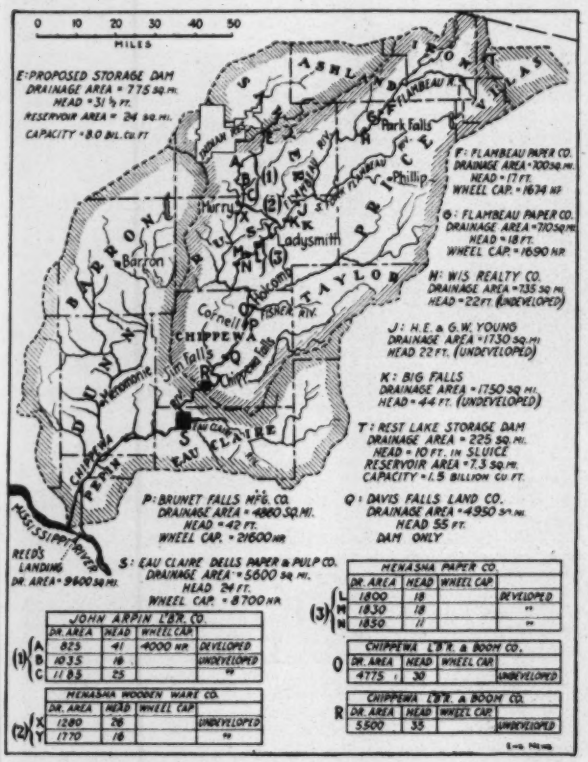


Fig. 1. Map of Drainage Area of Chippewa River

The larger part of the available power is located on the lower Chippewa River between the city of Eau Claire and the mouth of the Flambeau River, a distance of about 52 miles. Fig. 1 shows the location of the various water-power plants along the river, together with other features of interest in connection therewith.

The power available from the natural flow of the river at the various plants along the lower Chippewa River is shown in Table I, and is based on an assumption of a wheel installation at each plant, capable of using a maximum of 1 sec.-ft. per sq.mi. of drainage area in connection with certain stream-flow data as mentioned below.

TABLE I. APPROXIMATE AVAILABLE WATER POWER OF PLANTS ON THE LOWER CHIPPEWA RIVER

Plant	Drainage area, sq.mi.	Approx. head, ft.	Wheel installation assumed hp.[1]	Actual wheel installation, hp.	Av. wheel hp. for year or wheel hp.-yr. per annum[2] Dry yr.	Av. yr.	Wet yr.
Dells Pulp & Paper Co., Eau Claire	5600	24	12,100	8,700	6,400	8,600	9,700
Chippewa Falls	5500	35	17,300	(undeveloped)	9,200	12,200	14,000
Jim Falls	4950	55	24,500	(Dam only)	13,000	17,400	19,800
Brunet Falls							
Cornell	4860	42	18,500	21,600	9,800	13,100	15,000
Holcombe	4775	30	12,900	(undeveloped)	6,800	9,200	10,400
Totals		186	85,300		45,200	60,500	68,900

[1] Wheel installation assumed, as using when running at full capacity, 1 sec. ft. per sq.mi. of drainage area, and having an 80% efficiency of turbines.

[2] Average wheel horsepower for year or wheel horsepower-years per annum, available from the natural flow of the river, with a wheel installation of 1 sec.-ft. per sq.mi. of drainage area, and using an 80% efficiency of turbines.

A series of gage readings of the Chippewa River at Chippewa Falls, extending over a period of 24 years, from 1888 to 1911, were fortunately available from the records of the Chippewa Lumber and Boom Co. of Chippewa Falls.

During the years 1888-1909 the river was used for log driving purposes, water for floating logs down the stream being collected in a reservoir of about 600 million cubic feet, located at Holcombe, about 30 miles above Chippewa Falls. The natural flow of the river was thus slightly interfered with. Corrections for this have been made by distributing the stored water, determined from the increase in gage readings during the day when log driving occurred, over the previous period of time of from one week to four weeks, during which water was being stored.

The rating curve, used for the determination of the stream flow from the gage readings, was constructed from discharge measurements made by the U. S. Geological Survey, and was well determined between discharges of 1500 sec.-ft., and 25,000 sec.-ft. For values less than 1500 and greater than 25,000 sec.-ft., the percentage error may be taken as not exceeding about 15%.

The result of the study of these gage readings is shown in the form of certain curves (Fig. 2), termed *discharge duration curves*. Curves have been drawn to represent the average condition of stream flow for each of three types of years, extremely dry, extremely wet and average years. In drawing these curves the values of the discharge of the river, for each of the 365 days of the year, were arranged in their order of magnitude. The horizontal coördinates or abscissas of the curves represent percentage of time or percentage of the year that a given stream flow exceeded given amounts. The discharge and wheel horsepower, under 1-ft. head, apply only to conditions at Chippewa Falls, while the discharge in cubic feet per second per square mile apply, with reasonable accuracy, to the entire lower reach of the Chippewa River to the mouth of the Flambeau River.

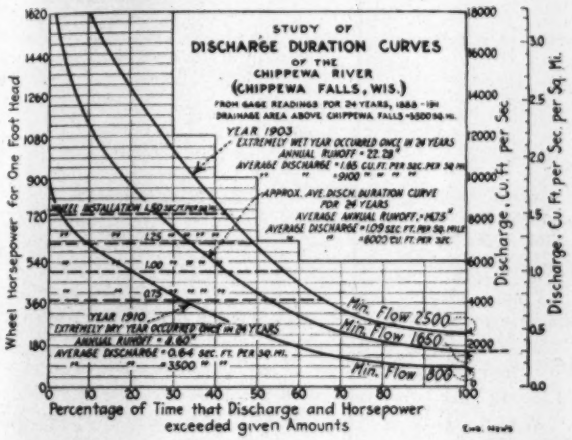
The comparison of the rainfall and run-off for the various types of years is shown by the following statement:

	Approximate rainfall, in.	Run-Off on watershed, in.	Run-Off, in Sec. Ft. per sq.mi. Average for year	Minimum
Extremely dry year, 1910	18	8.60	0.64	0.15
Average year	30	14.75	1.09	0.30
Extremely wet year, 1903	42	22.28	1.65	0.45

*Consulting Hydraulic Engineer, Madison, Wis.

The fluctuation in the rate of stream-flow for the various types of years is seen to be considerable.

By drawing a horizontal line on the discharge duration diagrams to represent the capacity of the wheel installation, information is furnished (1) as to the percentage of the year or number of days in the year that the stream flow would be less than the given wheel installation and (2) as to the amount of stream flow and power available on these days. The average ordinate of the discharge duration curve, below this horizontal line and the curves beyond, will represent the average stream flow and power available during the year from the natural flow of the river, with the given wheel installation. The ratio of the average power from stream flow to the wheel installation is the load factor of the turbines. When the stream flow exceeds the capacity of the wheel installation only a part of the power of the stream will be utilized. Table II shows the effect of wheel installations of from 0.75 to 1.50 sec.-ft. per sq.mi., for the three types


STUDY OF
DISCHARGE DURATION CURVES
OF THE
CHIPPEWA RIVER
(CHIPPEWA FALLS, WIS.)
FROM GAGE READINGS FOR 24 YEARS, 1888 - 1911
DRAINAGE AREA ABOVE CHIPPEWA FALLS = 5500 SQ. MI.
YEAR 1903
EXTREMELY WET YEAR OCCURRED ONCE IN 24 YEARS
ANNUAL RUNOFF = 22.28"
AVERAGE DISCHARGE = 1.85 CU. FT. PER SEC. PER SQ. MI.
" = 10100 " " "
APPROX. AVE. DISCH. DURATION CURVE FOR 24 YEARS
AVERAGE ANNUAL RUNOFF = 14.75"
AVERAGE DISCHARGE = 1.09 SEC. FT. PER SQ. MILE
" = 6000 CU. FT. PER SEC.
WHEEL INSTALLATION 1.50 SEC. FT. PER SQ. MI.
1.25 " " " "
1.00 " " " "
0.75 " " " "
YEAR 1910
EXTREMELY DRY YEAR OCCURRED ONCE IN 24 YEARS
ANNUAL RUNOFF = 8.60"
AVERAGE DISCHARGE = 0.64 SEC. FT. PER SQ. MI.
" = 3500 " " "
Min. Flow 2500
Min. Flow 1650
Min. Flow 800
Wheel Horsepower for One Foot Head
Discharge - Cu. Ft. per Sec.
Discharge - Cu. Ft. per Sec. per Sq. Mi.
Percentage of Time that Discharge and Horsepower exceeded given Amounts

of years mentioned, on the various factors such as percentage of year water wasting, load factor of turbines and percentage of power of stream utilized.

It will be noted that with a wheel installation of 1 sec.-ft. per sq.mi., roughly considered the economical installation, in average years the water would be wasting about 43% of the year, and only about 65% of the power of the stream would be utilized. Also that with this installation, the low-water stream-flow and minimum power would be only 15, 30 and 45% of the wheel capacity in extremely dry, average and wet years respectively.

In order to regulate the stream flow as much as possible, the owners of water-power plants along the Chippewa and Flambeau Rivers have recently organized the Chippewa and Flambeau Improvement Co., for the purpose of developing storage reservoirs at the headwaters of the Chippewa and Flambeau Rivers.

The result of a comprehensive investigation has shown that it will be feasible, at the present time, to construct storage reservoirs having a total storage capacity of about 15 billion cubic feet. The capacity of the proposed reservoirs will vary from a minimum of about 200 million cubic feet to a maximum of about 8000 million cubic feet.

For average and wet years the full reservoir capacity, of 15 billion cubic feet, would be collected in the spring and about 5 billion cubic feet in the fall, making a total of 20 billion cubic feet for the entire year. For extremely dry years, as 1910, occurring about once in 24 years, the reservoirs would only be about one-half filled.

On the basis of 100% delivery of storage water to the power plants, each billion cubic feet would furnish 32 sec.-ft. for a year, or 64 sec.-ft. 6 mo., or 128 sec.-ft. 3 mo., throughout the length of the river below the reservoirs.

In practice the percentage delivery will vary from about 60% to about 90%, depending on local conditions, such as increase in evaporation due to formation of new or increase in old reservoir surface, distance from reservoir to the main plants, total depth of withdrawal of water from the reservoir, conditions for storage in soil adjoining the reservoir, and other physical and meteorological conditions. In the reservoirs under consideration, it is thought that on the average 75% delivery will be realized at the main plants on the lower Chippewa River.

The effect of the proposed storage reservoirs of 15 billion cubic feet capacity on the water-power plants on the lower Chippewa River is illustrated by Table III, showing the effect on the Brunet Falls plant at Cornell, Wis. The drainage area intercepted is 4860 sq.mi.; the head developed is 42 ft.; the wheel installation is 21,600 hp. and is capable of discharging 5400 sec.-ft. or 1.11 sec.-ft. per sq.mi. of drainage area.

The effect of the storage, when distributed over a period of six months in an average year, is seen to increase the minimum power of the stream by 3650 hp., from about 5600 hp. to about 9250 hp., or about 65%. The average wheel horsepower throughout the year would be increased in average years by 1825, from about 14,000 hp. to about 15,825, or about 13%.

The main benefit is seen to be the increase in the min-

TABLE II. EFFECT OF WHEEL INSTALLATION ON AVAILABLE WATER POWER ON THE LOWER CHIPPEWA RIVER

Wheel Installation sec.-ft. per sq.mi.	Extremely dry year: % of year water wasting	Extremely dry year: Load factor of turbines	Extremely dry year: % of power of stream utilized	Average year: % of year water wasting	Average year: Load factor of turbines	Average year: % of power of stream utilized	Extremely wet year: % of year water wasting	Extremely wet year: Load factor of turbines	Extremely wet year: % of power of stream utilized
0.75	35	0.64	76	53	0.80	55	67	0.90	41
1.00	20	0.53	83	43	0.71	65	56	0.81	49
1.25	10	0.46	90	34	0.65	75	49	0.76	58
1.50	3	0.40	94	27	0.60	83	43	0.72	66

TABLE III. EFFECT OF STORAGE RESERVOIRS OF 15 BILLION CUBIC FEET CAPACITY ON STREAM FLOW AND WATER POWER AT BRUNET FALLS, CORNELL, WIS.

Type of year	Storage in billion cu.ft. Spring and Fall: Collect	Storage in billion cu.ft. Spring and Fall: Realize	Stream flow, sec.-ft.: Present min. low water flow	Stream flow, sec.-ft.: Increase in flow from storage 6-mo. period	Present wheel hp. from min. flow	Increase in wheel hp. from storage, 6-mo. period	% increase in min. flow and min. power	Average wheel hp. for year or wheel hp.-yr. per annum: From nat. flow*	From storage	Percentage increase in annual power
Extremely dry year, 1910.....	10	7.5	730	480	2800	1825	65	10,200	912	9.0
Average year.....	20	15.0	1450	960	5600	3650	65	14,000	1825	13.0
Extremely wet year, 1903.....	50	15.0	2190	960	8400	3650	44	16,200	1825	11.3

* Av rage wheel horsepower for year or wheel horsepower-years per annum, available from the natural flow of the river with a wheel installation of 1.11 sec.ft. per sq.mi., using an 80% efficiency of wheels.

imum power of the stream, by about 65%, and a material increase in power during the entire six-month period when the capacity of wheel installation exceeds the stream-flow.

Should the storage power be distributed over a shorter period than six months, as is probable with the paper-mill industry, the percentage increase in minimum power would be greater than 65%. For an average year with distribution of storage power over a period of four months, the minimum stream-flow would be increased by 1440 sec.-ft. instead of 960, making an increase in minimum power of 5475 hp., or about 100%.

The increase in annual power from storage, measured in wheel horsepower-years, and the percentage increase in the average wheel horsepower throughout the year, would remain about 13% for average years, and would be independent of the period of distribution.

The cost per million cubic feet of storage capacity, including cost of flowage, will vary from about $20 to $30. The annual cost per wheel horsepower-year for the storage power, including interest, maintenance and depreciation, will vary from about $2 to $7, depending on local conditions.

The Use of Alum in Connection with Slow Sand Filtration at Washington, D. C.*

By William Firth Wells†

In the report leading to the adoption of slow sand filtration at Washington, Messrs. Rudolph Hering, George W. Fuller and Allen Hazen urged the occasional use of alum:

In consideration of the full evidence, we recommend the construction of a complete system of slow or sand filters, with such auxiliary works as may be necessary for preliminary sedimentation, and the use of alum for part of the time. There is no reason to believe that the use of this coagulant will in any way affect the wholesomeness of the water.

Popular prejudice was opposed to the application of alum, and for five years the plant labored, during periods of bad water, under a load which it proved impossible to completely reduce.

There were times when the cloudiness in the filtered water could be observed in a drinking tumbler, and the bacterial count sometimes rose above the liberal German limit of 100 per c.c. Often the filters were unfairly criticized even when giving a greater percentage purification than the average plant.

Few plants can continuously reduce a clay-bearing water, such as the Potomac River, whose contamination fluctuates sharply and widely, to a water of assured constant purity. The efficiency of such a system must vary directly with the conditions, and it means at times an exceptionally high percentage purification. Experience has shown that slow sand filters alone cannot deliver a satisfactory effluent when the turbidity of the raw water greatly exceeds 30 parts per million, however efficient they may be with a water clearer than this. If combined with processes which can economically remove the bulk of the solids and keep the water on the beds below 30 p.p.m. they give remarkable results.

An ideal system is best prepared to handle that water at each stage of its purification. The slow sand filter is a most delicate instrument, best adapted for the final process.

At Washington the water is treated in four steps:

1. Over one-third of the mud which would otherwise enter the system is eliminated by closing the gates.

2. The coarser material (about half that which enters) settles out in two days' storage in Dalecarlia Reservoir.

3. Nearly two-thirds, by weight, of the finer particles left sediment in two days in Georgetown and three days in McMillan reservoirs.

4. Practically all the remainder is taken out by the filters.

In Fig. 1 the turbidities have been arranged in order of magnitude. The area under each curve represents the quantity of turbidity at that station, during the period, and the areas between the curves represent the quantity removed between two stations. These curves approximate closely the logarithmic form,

$$\log y = ax + \log b$$

for values of y under 90. It is easy to integrate between $y = 0$ and $y = 90$ and obtain the area accurately enough for practical purposes. The constants for Fig. 1 have been roughly determined as follows:

	1906–1911		1912	
	a	b	a	b
Great Falls	1.7	115	...	...
Dalecarlia Outlet	1.0	120	1.5	100
McMillan Outlet	0.54	135	0.11	550

These curves illustrate two well-recognized characteristics of plain sedimentation:

1. Settling progresses more rapidly at higher turbidities.

2. Even so, a week of storage is not enough to prepare the worst water for perfect slow sand filtration. In other words, the processes possess a certain degree of flexibility tending to maintain a more constant condition in McMillan Reservoir, but are not flexible enough to render the filtered water constant. Whenever the turbidity of the water at Dalecarlia outlet is above 50, corresponding to a turbidity of about 75 in the river, the filters become overloaded.

In 1908 Mr. Francis F. Longley reported an exhaustive series of experiments on the preliminary treatment of the water after two days' sedimentation in Dalecarlia Reservoir. Hhe concuded, among other things, that:

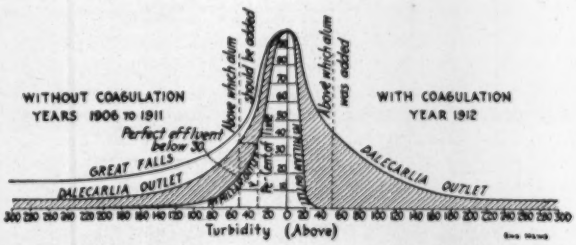


Fig. 1. Percentages of Time during Months of January to July during Which River and Settled Water and Water after Alum Treatment, Washington Water-Supply, Were above Given Turbidities

(Great Falls denotes water at river intake. Delecarlia and McMillan are names of reservoirs.)

The desired improvement in the water can be effected by occasional coagulation, with subsequent thorough sedimentation in the two existing reservoirs. Thos process is so entirely flexible that with its use the final product of the filters, so much desired, is assured.

The opposition to the use of alum at Washington gradually subsided, with the increasing experience with mechanical filters throughout the country, until in 1910 Congress appropriated money for the construction of a coagulating plant and the purchase of alum. During the winter months, beginning 1911, alum was at times dumped directly into the conduit between Dalecarlia and Georgetown Reservoirs with excellent results. In 1912 the plant was in operation and alum was added to the conduit at Dalecarlia outlet when the turbidity there arose above 50, according to the schedule prescribed by Mr. Hazen. The daily quantities are given by the lower black areas in Fig. 2.

On March 23, Georgetown Reservoir was drained to begin the work of remodeling it for a sedimentation basin. The writer has chosen the months January to July for comparison in every case as it was during this period that the most alum was added. Alum was added on 83 of the 182 days, usually in amounts between 1 and 2 grains per gal. The total amount was 863,230 lb., and the water pumped during the period was 11,634,000,000 gal. The average cost per 1,000,000 gal. during the six months figures out to nearly $0.70.

The results of the treatment, as may be observed by comparison with the same period during the previous five years (Fig. 1) exceeded the most sanguine expectations. The slight rise in the curve is due to unavoidable difficulties met with, at first, in the long spells of bad weather. Except for this McMillan Reservoir was kept uniformly in much better condition than was requisite to deliver a perfectly clear effluent from the filters. Fig. 2 shows in detail the effect of the

*Abstract of a paper read before the American Water Works Association, June, 1913.

†Of the Filtration Plant, Washington, D. C.

alum. The schedule is liberal and with a little trimming would still admit of a clear effluent. But the excellent condition of McMillan outlet insures a higher bacteria removal than could be obtainable when the alum was just sufficient for a clear effluent, and surely the slight added expense is amply justified in securing a water at the nation's capital as pure as from a spring.

When the turbidity of the water going onto the Washington filters is under 20 for 90% of the time, and under 10 for 30% of the time, it is hardly necessary to discuss the filtered water in detail. The results are given by months in the accompanying table. There are factors, however, which go to make the water even better than under similar conditions without the use of alum. First, the turbidity is much coarser than would be the same turbidity left after plain sedimentation. Not only is it easier for the filters to take it out but it puts them in better condition. Second, by keeping the water on the beds in uniformly clean condition the filters become purged of the resistant organisms lodging within its body. These are mostly hardy soil forms and spores which can survive the long stumbling passage through the filters, which may take days or weeks. This leads to a remarkably high purity of the filtered water. It is not advisable to add hypochlorite to the filtered water, because:

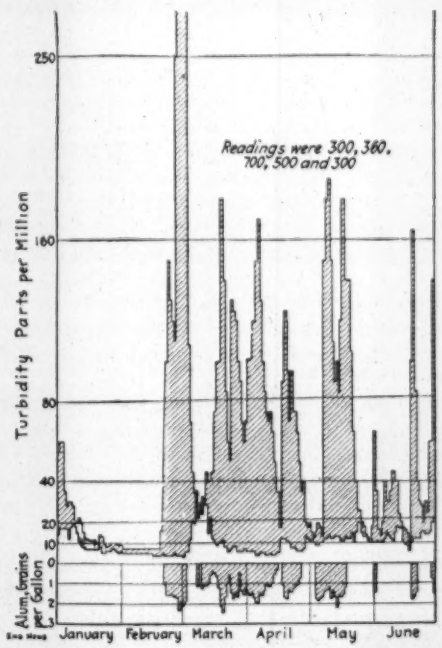


FIG. 2. TURBIDITY AND ALUM ADDED AT DELECARLIA RESERVOIR OUTLET, WASHINGTON WATER-SUPPLY, AND REDUCTION OF TURBIDITY AT MCMILLAN RESERVOIR OUTLET, JAN. 1 TO JUNE 30, 1913

1. In reasonable quantities it will not kill these forms. 2. They are entirely harmless. 3 The water is of the highest purity without it.

TURBIDITY AND BACTERIA IN THE WASHINGTON WATER SUPPLY, JUNE, 1913

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
				Turbidity				
Great Falls	22	580	615	222	165	207	970	59
Dalecarlia Inlet	22	250	207	110	155	66	496	..
Dalecarlia Outlet	18	82	96	78	72	43	186	43
McMillan Outlet	12	5	14	7	12	13	22	24
Filtered Water	1+	0	0	0	0	0	0	0
				Bacteria				
Dalecarlia Inlet	7900	36,650	18,250	4010	8570	860	1590	534
Dalecarlia Outlet	7130	30,350	13,250	2980	2100	394	780	221
McMillan Outlet	3640	4,410	2,100	180	179	103	60	91
Filtered Water	203	89	53	6	5	3	4	3

A possibility was at first feared that some alum floc would carry over and clog the filters, rapidly increase the loss of head and shorten the runs. No floc ever appeared in McMillan outlet, nor until March 23, when Georgetown Reservoir went out of service, was any observed in McMillan inlet. On the contrary, the load being taken from the filters, the runs were lengthened and the cost of cleaning the filters was reduced. It is hard to get an accurate measure of the exact saving in filter operation, due to alum treatment, as the work on the filters is more or less arbitrary. But some idea can be gained from the quantities of sand handled. During January to July, 1906 to 1911, the average per month was 1808 cu.yd.; the same months in 1911 it averaged 1353 cu.yd., and in the exceptionally bad months of 1912 it was only 1259 cu.yd. This is a reduction of 549 cu.yd. or 30% of the original quantity and nearly a half of the present amount. Figured at the average cost per yard of $0.34, the saving during the six months was $1180 or 14.5% of the cost of alum during the period.

The possibility of reducing the cost by increasing the rate has not been investigated under the favorable conditions created by the preliminary treatment. Judging from the rate experiment carried on, previous to coagulation, it would seem feasible to double the rate or even raise it much higher and still maintain a high standard of purity.

CONCLUSIONS

1. Seven days' storage is not sufficient to prepare the Potomac water, when the turbidity is above 100, for satisfactory slow sand filtration.

2. Preliminary treatment with alum introduces an ideal flexibility into the system, whereby the turbidity of water flowing onto the filters may be kept uniformly below 20 (or lower if desired).

3. Filtration of this water yields a water of constant purity, perfectly clear, and with less than 10 bacteria per c.c.

4. The few bacteria surviving filtration are mostly harmless hardy soil forms, making it inadvisable to add hypochlorite.

5. Cutting down the peak load greatly reduces the cost of the filter operation, and the treated water keeps the beds in better condition.

6. The rate of filtration following alum treatment can be more than doubled to advantage, and an economical balance struck between the rate of filtration and the quantity of alum.

A Very Large Contract on a cost-plus-a-percentage basis is pending between the Interborough Co. of New York City and John F. Stevens, formerly Chief Engineer of the Panama Canal. The contract is for the construction of new elevated lines and the addition of a third track on the present elevated roads in connection with the extension of the New York Rapid Transit System under the Interborough lease. The estimated cost of the entire work is in the neighborhood of $25,000,000, and the contract with Mr. Stevens is that he is to be remunerated the actual cost of the work plus an unnamed percentage, which according to reports is to be 10%, or a profit of two and one-half million dollars on the contract. Protest against the award of the contract on this basis has been made by George McAneny, President of the Borough of Manhattan, who had a most important part in drafting the terms of the contract between the city and the Interborough company under which the new rapid transit lines are being built. Mr. McAneny urges that while the Interborough in the first instance pays the contractor his cost and profit, the city is also vitally interested since the more the construction work costs, the more the city will have to pay if, at the end of a term of years, it exercises its rights to purchase the lines. The city is also interested by reason of its share in the net profits.

This share will be reduced by any unnecessary increase in the cost of the work. Mr. McAneny in a letter to the Public Service Commission says:

It was the assumption of the negotiators for the city that, in order to secure the lowest rate of cost, the contracts for construction and equipment let by the company would be let under competitive bidding. I find that the contract now submitted for your approval goes to the other extreme. John F. Stevens is named as the contractor, without invitation for bids from any other source; and it is provided that Mr. Stevens shall be paid, not a definite sum, to be fixed by the contract and entered at once in the cost of construction and equipment, but that he shall do all the work involved "for the actual cost and expense incurred plus —— per cent."

You are asked, in short, to approve a contract in which there is no possible doubt as to the profit of the contractor, and under which, upon his own statements of cost and expense, he is to be allowed a flat sum, even the percentage of which the contract fails to name.

I have understood that the allowance actually in the minds of the officers of the company is 10 per cent. Upon the estimated amount of the work this would mean a direct payment to Mr. Stevens of $2,500,000, with full relief from the usual contractor's risk; with a premium, on the other hand, placed upon excessive cost, and with absolute denial to the city—which has, in a sense, a partnership interest of the advantages of competitive bidding for the lowest price obtainable.

A Neglected Source of Power in Nature

By Ben. J. Campbell*

Grave concern is felt by mankind over the increasing rapidity with which the earth's coal and oil stores are being exhausted and it is predicted that within but a few generations the available supply will be so far reduced that engineers will have to turn to other sources for the ever increasing power demanded by modern civilization.

Of the natural sources of energy, water power is of greatest importance and will be the first to be completely harnessed. Wind mills, the tides, ocean waves and solar heat will each receive due attention and be utilized to a limited extent, but all the above named, developed to the utmost will fall far short of meeting the demands.

However, a natural source of power exists which is abundantly able to supply all power needed by future man, when the problems of electrical transmission and intensive methods of storing up energy in a transportable form shall have been solved.

In this paper it is endeavored to outline and bring to the attention of engineers the possibility of utilizing the difference of temperature between the surface and subsurface water of the ocean as a source of power.

As is well known, the mean surface temperature of tropical seas is about 80° F., often reaching 85° near the Equator, while at about 300 fathoms depth in many places in the Atlantic a temperature of 40° F. is found, decreasing to about 32° near the bottom. This difference of temperature represents an indefinitely large storehouse of potential energy, inexhaustible by man, which by means of a heat engine working on the Carnot cycle using a suitable volatile fluid, can be converted into power.

The warm surface water constituting the source of heat, would evaporate the fluid under pressure, and after the vapor had done external work by expanding in a nozzle or cylinder, the cold sub-surface water would condense the vapor to a liquid ready to use over again.

It seems incredible that the possibilities of power from this source should have been overlooked; and one can but think that the idea has occurred to many men but has been dismissed with scant thought and without investigation, on account of the small temperature range and the apparent impracticability of bringing the cold water to the surface.

I will select a typical installation and briefly describe the important and fundamental features.

A floating power house would in most cases be required, but in some of the Coral Islands in the tropics deep water is found sufficiently near land for the power plant to be located on shore. Of first importance is bringing the cold condensing water to the surface.

Consider a flume or conduit of 12 ft. inside diameter projected down from a floating power house to a depth of 300 fathoms or 1800 ft. This at first, though, would appear utopian, but upon closer scrutiny it seems to be entirely practicable.

The flume could be built of wood with metal bonds, nails, etc., of such weight that it would be equal in specific gravity to, or slightly lighter than the sea water and hence would be entirely supported by the water and could be extended downward to any depth. If constructed lighter than the water its lower end would, of course, have to be weighted.

Near the surface an elastic or telescopic construction would be required on account of waves and surface currents, which, however, disturb the water near the surface only, the water below about 300-ft. depth being never sensibly disturbed by surface conditions. The velocity of sub-surface ocean currents in the tropics is imperceptible.

The column of cold water in the flume is somewhat heavier than the outside water, the static difference of head or level resulting therefrom being equal to about 1.73 ft.

The head required to produce a mean velocity of 8 ft. per sec. in the flume is, according to Kutter's formula with value of $N = 0.012$ (see Kent), equal to 2.02 ft. Total equivalent head to bring the 40° F. water to the surface at a velocity of 8 ft. per sec. = 3.75 ft.

Quantity of flow $= 36\pi \times 8 = 904$ cu.ft. per sec.

Work required to raise this water equals

$$\frac{904 \times 64.04 \times 3.75}{550} = 394 \text{ hp.}$$

With a screw propeller or centrifugal pump of 70% efficiency the actual power required would be $\frac{394}{0.70} = 563$ hp.

The heating and condensing surfaces must be kept within practical limits; therefore, the extreme temperatures of 80 F. and 40 F. will not be attained by the working fluid.

Deducting 8° from the upper and adding 12° to the lower temperature gives the working values of 72° F. and 52° F.

The theoretical thermal efficiency is

$$\frac{T_2 - T_1}{T_1} = \frac{20}{512} = 3.9\%$$

Here the thermal efficiency is referred to the condenser water temperature T_1, as the source of heat T_2 is that of the surface water, or surroundings and is abundantly available without cost.

In steam engines with but little expansion (50% cutoff) the indicated efficiency is about 65% of the theoretical as given by the formula $\frac{T_2 - T_1}{T_2}$, mechanical efficiency about 87%, electrical about 92%, therefore on this basis the net electrical efficiency would equal about

$$3.9 \times 0.65 \times 0.87 \times 0.92 = 2.03\%.$$

If the temperature of the condensing water is raised to 10° F., and the net electrical efficiency is but 1.5% instead of about 2% as found above, the net electrical horsepower would equal

$$\frac{904 \times 64.04 \times 0.93 \times 10 \times 0.015 \times 778}{550}$$

$$= 11{,}400 \text{ hp. for a 12-ft. flume.}$$

The condensing water required on the above basis equals $\frac{904 \times 60 \times 60}{11{,}400} = 285$ cu.ft. per electrical hp.-hr.

The condensing surface required on the same basis with water circulated about 5 ft. per sec., at a mean difference of temperature of 5.58°, and about 600 B.t.u.

*Engineering department, Keuffel & Esser Co., Hoboken, N. J.

transmitted per deg. per sq.ft. per hour equals $\frac{235 \times 64.04 \times 0.93}{600 \times 5.58}$ = about 51 sq.ft. per electrical horsepower, or about 41 sq.ft. per indicated horsepower.

The heating surface required will be somewhat less than for condensing, 8° was deducted from surface-water temperature as a driving force and if pipes are openly spaced and a surface current exists, or the water is circulated, the mean difference of temperature will be over 8° as the lowering of the surface temperature will be negligible, and the fluid will be heated from the condenser temperature of 52° to 72°, then evaporated at 72° F.

While any fluid suited for refrigeration could be used as a working fluid, carbonic acid seems to be especially suitable, it being relatively cheap, noncorrosive, nonexplosive and having sufficient difference of pressures at the available temperatures to give a high mean effective pressure.

Pressure of CO_2 at 72° F.	= 971 lb. per sq.in.
Pressure of CO_2 at 52° F.	= 667 lb. per sq.in.
Working difference of pressure	= 204 lb. per sq.in.

Carbonic acid would also be well suited for driving a turbine, its density is about six times as great as steam at the same pressure, therefore, for the same kinetic energy a much greater mass would flow, but at only about 40% of the velocity of steam and it could be efficiently handled in a simple, single stage or "few-stage" impulse turbine.

The small amount of manual labor would compare favorably with a hydro-electric plant, and it may be noted that there would be in the operation of the plant: no firing of boilers; no incrustation or scale troubles; no overheating or expansion troubles; no vacuum pump; small depreciation; small or no taxes on the high seas.

The commercial possibilities at the present time would be practically limited to such industries, that geographical locality is of minor importance, but cheap and abundant power of prime importance. Of this class may be mentioned the fixation of atmospheric nitrogen; liquifaction of air for power and refrigeration purposes and the production of calcium carbide.

Damage to Bulk Cement and Sacked Cement by Wetting in Transit

By J. H. Libberton*

Since the shipment of cement in bulk is still to a certain extent in an experimental stage, a good many questions relative to the handling of cement in this way remain to be answered. Many persons, particularly railway men, have felt that the bulk material would be more liable to loss or damage in transit, on the ground that sacks acted to a certain extent as a protection against rain entering the car through a leaky roof, side or door. The Universal Portland Cement Co. has made some experiments to determine the effect of rain on each style of shipment under identical conditions.

For this purpose a box was used, 8x4 ft., 3 ft. high, capable of holding 112 sacks of cement piled as they would be in a box car. Suspended at a height of 8 ft. 6 in. above the box was a triangular trough 4 ft. long and approximately 7 in. high, and closed at the ends. The construction of this trough was such that there was no head of water above the drip. The water in running through a slot in the bottom of the trough did not drop directly upon the cement, but ran down the end of the board and then dripped onto the cement, thus duplicating the conditions that would exist in the case of a leaky car roof.

The first experiment was made with 28 bbl. of cement in 112 cloth sacks, and 83 lb. of water was allowed to drip from the trough upon the sacks. The application of this amount of water required 45 min. After the cement had been given ample time to harden (about four days), two men proceeded to recover all the undamaged cement and sacks and to put them into marketable condition. Of the sacks, 61 were more or less damaged, and from these lumps of caked or set cement weighing 584 lb. were screened with a three-mesh sieve. Five of the sacks were so badly torn in removing the set cement from them that they had to be discarded. None of the sacks had started to rot, because they had not been exposed to the action of the water for a long period.

A summary of the cost due to the damage is as follows: Labor, 11 hr. at 25c., $2.75; cement, 1.55 bbl. at $1.50, $2.32; sacks, 5 at 10c., 50c.; total, $5.57.

The second test consisted in placing 28 bbl. of bulk cement in the same box. Water was added as before, and the cement was allowed to harden for the same period of time, after which it was possible to remove practically all of the damaged cement in one lump weighing over 500 lb. What little hard cement occurred outside of the one large lump was occasioned by the spatter from the central pocket. This cement was easily saved by simply scraping over the top and removing only the surface, which included all of the hard lumps. The cement damaged in this case was 615 lb., or 31 lb. more than with the sacked cement, probably due to the fact that the sacks absorbed a certain amount of the water applied, thus cutting down the cement damage slightly.

The maximum cost claim which could be advanced in this case by a consumer receiving cement with a leaky car roof, as described, would be as follows: Labor, 1 hr. at 25c., 25c.; cement, 1.64 bbl. at $1.50, $2.46; total, $2.71.

The net result of these two experiments shows a loss of $5.57 chargeable to sacked cement and $2.71 to the bulk cement, under identical conditions. This justifies the inference that the liability of a railway for damage by wet to a shipment of bulk cement would be less than 50% of its liability in case the cement had been contained in cloth sacks.

*Assistant Engineer, Universal Portland Cement Co., Chicago.

Important Terminal Improvements in Philadelphia will result if the plans of the Pennsylvania R.R., the Baltimore & Ohio R.R. the Belt Line R.R. and the city are carried out. The agreement entered into by these parties, July 7, must go to the law department of the city and to the counsel for the railroads for examination, and to become effective, must be approved by the City Councils. The plans include the abolition of all grade crossings in South Philadelphia, the construction of railroad and water terminals, the extension of the Belt Line R.R. and the reclamation of 4000 acres of waste land. The reclaimed land will be the site of one of the greatest railroad terminals in the world. It will be used jointly by the Pennsylvania and the Baltimore & Ohio railroads, and reached over a four-track causeway. Upon the sites of the present railroad river front terminals, which the city will acquire, the municipality will construct piers of sufficient capacity to meet the requirements of ocean transportation.

Requisites for Apparatus for Train Control

At the last meeting of the American Railway Association a committee made a report on the general subject of automatic train stops defining what conditions such devices should fulfil in order to be acceptable for railway use. In presenting the report Mr. E. C. Carter, Chief Engineer of the Chicago & Northwestern, the Chairman of the Committee stated that none of the devices have yet been developed to a point where all these requirements are fulfilled.

In presenting the report it was stated that this list of requirements was tentative only and was subject to further consideration and amendment by the committee in the light of greater experience. The report follows:

DEFINITIONS

AUTOMATIC STOP—An apparatus for stopping trains by a device actuated from outside the train.

CAB SIGNAL—A signal located in the engine cab indicating a condition affecting the movement of the train.

TRIP—The bar, lever, or other device, fixed along the roadway, which, when in a certain position, actuates the apparatus on the train, by which an application of the brakes is effected.

REQUISITES OF INSTALLATION

1. The apparatus so constructed that the failure or displacement of any essential part

(a) along the roadway will cause the display of the "stop" indication by the fixed signal and also the application of the brakes.

(b) on the train will cause the application of the brakes.

2. The apparatus so constructed that proper operative relation between those parts along the roadway and those on the train will be assured under all conditions of speed, weather, wear, oscillation and shock.

3. The train apparatus so constructed as to prevent the release of the brakes after automatic application has been made until the train has been brought to a stop or the speed of the train has been reduced to a predetermined rate.

4. The aparatus so constructed that a train may pass an automatic stop in the tripping position without brakes being applied, provided the train speed is less than a predetermined rate and the fixed signal indicates proceed.

5. The apparatus so constructed that when actuated it will first make a service application of the brakes, then if the engineman does not perform certain predetermined operations it shall go to emergency application.

6. The trip shall be located at such a distance from the home signal that any train can be brought to a stop by the application of the brakes before it reaches the home signal.

7. The apparatus so constructed as not to interfere with the application of the brakes by the engineman's brake valve.

8. The apparatus so constructed as to be operative when the engine is running forward or backward.

9. The apparatus so constructed that when two or more engines are coupled together or a pusher is being used the apparatus can be made effective on the engine only from which the brakes are controlled.

10. The apparatus so constructed as to be operative on trains moving only with the current of traffic.

11. The apparatus so constructed that the control is through the ordinary means used for giving the fixed signal indications.

Note—When track circuit is used it should be so designed as to be noninductive.

12. The apparatus so constructed as to conform to the American Railway Association standard of clearances of rolling equipment and structures.

13. The apparatus so constructed and installed as not to constitute a source of danger to employees, or passengers.

ADJUNCTS

The following may be used:

(A) Cab signal; to be located in front of the engineman and at the same time visible to the fireman, and to be so constructed

(1) that the failure of any part directly controlling the signal will cause it to display the "stop" indication.

(2) that when no cause for stopping the train exists a definite "proceed" indication will be given at every point where a "stop" indication would be given if the automatic stop had been set to apply the brakes; or it will display indications continuously in districts of congested traffic.

(B) Recording device; so constructed as to make a record of the number of times the automatic stop has operated the brakes.

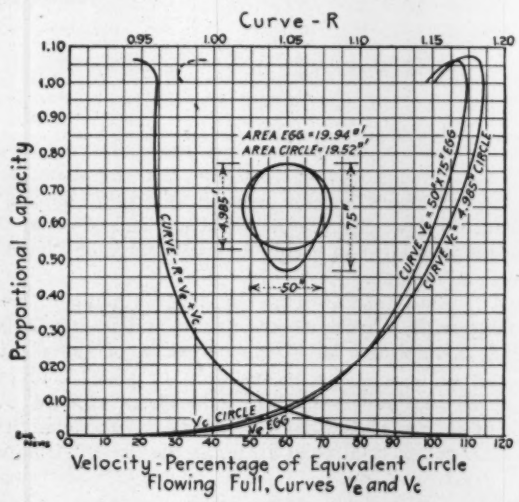
(C) Speed indicator.

⁂

Hydraulic Comparison of Equivalent Egg-Shaped and Circular Sewers

By Robert S. Beard* and O. L. Eltinge*

Sanitary engineers adopt egg-shaped sewers in preference to circular-shaped sewers generally because of the hydraulic advantage of the egg-shaped sewer when carrying relatively small quantities of sewage. This advantage and that of a narrower trench must overbalance the advantage of the circular sewer in strength, economy of section, and depth of cut.


Curve - R
Proportional Capacity
Velocity - Percentage of Equivalent Circle Flowing Full, Curves Ve and Vc
AREA EGG = 19.94 sq ft
AREA CIRCLE = 19.52 sq ft
CURVE Ve = .50X.75" EGG
CURVE Vc = 4.985' CIRCLE
Vc CIRCLE
Ve EGG

HYDRAULIC COMPARISON OF EQUIVALENT EGG-SHAPED AND CIRCULAR SEWERS WHEN FLOWING FULL

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(Kutter's formula, n = 0.013. S = 0.001. 50x75-in. Egg-shaped = 4.985-ft. circular sewer.)

The accompanying diagram is a hydraulic comparison of a 50x75-in. egg-shaped sewer with the circular-shaped sewer of equivalent capacity when both are flowing full on a 0.1% grade, their common friction factor being 0.013. While this is a particular case the same hydraulic ratio will hold true for all practical purposes, throughout a considerable range of conditions. The curves V_c and V_e give the velocities of equal quantities of sewage flowing in the two types of sewers. They are expressed in terms of the velocity of the sewage in the circular-shaped sewer when flowing full. The curve R gives the relative velocities of the same proportional quantities of sewage flowing in the egg- and circular-shaped sewers.

We believe that this comparison is much less to the advantage of the egg-shaped sewers than engineers have generally supposed.

⁂

The Population of New York City was 5,322,000 in mid-April, according to estimates by the local health department.

*Sewer Division, Board of Public Works, Kansas City, Mo.

A Trackless-Trolley Motor for Assisting Haulage on a Steep-Grade Street

By J. P. Schroeter*

After Europe has demonstrated the reliability and economy of "Trackless Trolley Traction," the United States slowly begins to realize the advantages of this system. As is well known its characteristic feature is the absence of rails, thus allowing a certain radius of operation on both sides of the trolley wires. The advantages are, light weight of the cars, simple control, cheapness of installation, flexibility. "Trackless Trolley Traction" is therefore adapted for cities with insufficient traffic to warrant the investment of large capital, or for lines between railroad stations and resorts, or as feeders for electric-street railways on streets where because of traffic or narrowness of streets tracklaying is impracticable.

The trackless-trolley vehicle is intermediate between the autobus and the electric car. It resembles the first as to the construction of the car body, but its driving motor is fed from the central power station. The overhead construction consists, of course, of two wires, because the missing rail-return must be provided for. The current-collecting devices differ, depending upon the system used, but all are similar in that they permit the car a certain freedom of movement to either side of the trolley wires, thus enabling the meeting, overtaking and passing of other vehicles.

A new application of the trackless-trolley motor has been recently made in Altona, Germany, near Hamburg. Some of the Altona streets leading from the docks on the Elbe have such a steep grade that they cannot be used for traffic; other streets have a grade of 5 to 6%. The heavily loaded teams coming from the docks up to the city have much difficulty in climbing this grade. In 1911 the City of Altona contracted for trackless-trolley motors to assist trucks up the hill. These motors take the place of extra horses formerly used. They are supplied with 550-volt direct current from a power plant in Altona. The return trip is made by the motors with the contacts removed from the trolleys, by simply coasting down the hill.

The accompanying cuts show very clearly the arrangement. The tow rope from the motor is attached to the wagon and the horses do their share of the work. The horses quickly accustomed themselves to the new motor and patiently wait for it to start before they begin to pull. As will be seen from the pictures, the locomotives are arranged to push as well as pull, and can assist several loaded wagons in a string. A fee of 12 to 45c. is charged for the haulage, according to the load. During 1912 a total of 26,038 wagons were assisted by the motors, showing that the small fee was considered a good investment by team owners on account of the saving of time and the avoidance of over-exertion of the horses. The trip up the hill is made in eight minutes and the time for coasting down and coupling the next set of wagons is seven minutes, so that four trips an hour can be made. In October, 1912, 3343 wagons were hauled by one motor.

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A Trackless Motor for Assisting Loaded Teams Up a Steep Grade at Altona, Germany

Wire Wheels for automobile use are claimed to be likely to supersede the wooden wheels now generally used. The American Steel & Wire Co., 72 West Adams St., Chicago, has published a pamphlet describing the design and detail construction of all the wire wheels now on the market. The complicated stresses in a wire-suspension wheel and the special problems in connection with its detail construction make its design especially interesting to engineers. Comparative tests of the resistance of wire-spoke and wood-spoke wheels to deflection under an impact test made by a heavy swinging pendulum showed that the wire wheel had on the whole greater resilience than the wooden wheel.

The Temperature of Steam in a Superheater depends upon its design, amount of tube surface, the number of passes which the steam makes over the surface, the weight of the steam and the volume and temperature of the hot gases. Two methods of controlling superheat temperature are first, to regulate the volume of steam passing through the superheater tubes so that after it has been mixed with saturated steam from the boiler, the mixture will have the desired superheat, and secondly, to regulate the amount of hot gases passing over the superheater tubes, that the desired steam temperature may be obtained for any weight of steam passing through the superheater tubes. The first method is open to the objection that hot gases are always flowing over the tubes, and therefore if no steam, or only a small quantity of steam, is passing through the tubes they are liable to overheating. Heine superheaters have been arranged to operate by the second method. The superheater is located in a firebrick superheater chamber, forming part of the boiler setting, at the side of the boiler drum. The rear of this chamber communicates with the furnace by a flue, through which a small percentage of the furnace gases rise, making two passes over the superheater tubes, and then flowing out to the front at the bottom of the superheater chamber, where a damper is located, controlled by an automatic regulator to maintain a constant superheat. This regulator consists of a diaphragm lever, actuated by compressed air, and a thermostat controller for regulating the admission of the air to the lever, depending upon the temperature of the steam. An advantage of control apparatus with superheaters is that the temperature may be changed as desired after the plant is installed. The thermostat controller has a small dial and adjusting screw, whereby the mean temperature maintained may be raised or lowered as desired. By keeping records of the load and of the coal consumed, the most economical working conditions can be determined.

Improved Slip-Switch Crossings: Pennsylvania R.R.

In large yards, and especially in the track layouts of the approaches to large passenger terminal stations, the use of double-slip crossings is usually necessary to provide the requisite flexibility of connections for movements between the various tracks. In this type of layout, a diagonal track crosses the several parallel main tracks, and has at each intersection a double set of switch rails so arranged that trains can be diverted from the diagonal track to the running track (or the reverse) in either direction. The crossing is in effect an extended crossover, with the facility of providing connection with any of the tracks which it intersects.

While this type of special track work is a necessity, and is essential to the convenient handling of movements at a terminal, it is an expensive construction and involves considerable trouble and expense in maintenance. This maintenance expense is due to the number of moving parts, the necessarily sharp curves through the slip switches, and the heavy wear and tear caused by the frequent passage of wheels exerting grinding and lateral forces upon the switches and frogs. There is also the possibility of derailment from the failure of some part under the severe service. It is obvious that there are considerable difficulties in making adjustments and repairs to such complicated track construction, affecting several tracks and interfering with heavy traffic.

Improvements to such layouts, which will reduce the wear and make the construction more permanent, are specially desirable and of more than ordinary importance. We have pleasure, therefore, in describing an improved design of movable double-slip crossing designed by the Pennsylvania R.R. For drawings and information respecting this we are indebted to the office of the Engineer of Maintenance-of-Way of that company.

In Fig. 1 is shown the construction of a No. 8 crossing of this new type. The first of these was installed in the Broad St. station yard at Philadelphia, over a year ago, and has given thoroughly satisfactory results. The railway uses also double slips of Nos. 6, 10, 15 and 20, of the same general design, and has installed these at various points on its system. In the No. 8 crossing the frog angle is 7° 9′ 10″; the switch angle is 1° 49′ 48″, and the curve of gage side of the outer rail of the slip is 697.56 ft. radius, or a curve of 8° 13′ 14.8″. The switch rails are 15 ft. long and the movable point rails 12 ft. 4½ in. long, while the throw at the switch points and the movable frog points is 4 in. The distance between frog points of the No. 8 rigid frogs at each end of the crossing is 76 ft. 1¾ in. Fig. 2 shows a double-track ladder in the Broad St. station yard, with double slip-switch crossings at all track intersections. Fig. 3 is a diagram of one of these intersections.

One of the special features of this design is in securing a greater radius of curvature through the slips, and thus obtaining a freer movement of the trains with less wear and tear on the parts. In the No. 8 crossing the radius is now 697.56 ft. instead of 352.7 ft. as in the older design. Other improvements are in the line of more substantial construction. Cast-steel blocks are applied at the heels of the switches, so designed as to give a free movement of the switch points and at the same time make a very rigid joint at these places. Additional bridle plates have been added, extending practically the full length of the ties and securely fastened to the ties with lag screws.

Adjustable rail braces applied throughout the slip give considerable strength and rigidity, besides maintaining the rails in their normal positions. The switch rods attached to the movable rails project and slide beneath the fixed rails, and thus serve to maintain the rails at the proper surface or level. Long steel anchor straps bolted to the rails and attached to the ties by lag screws, serve to prevent creeping.

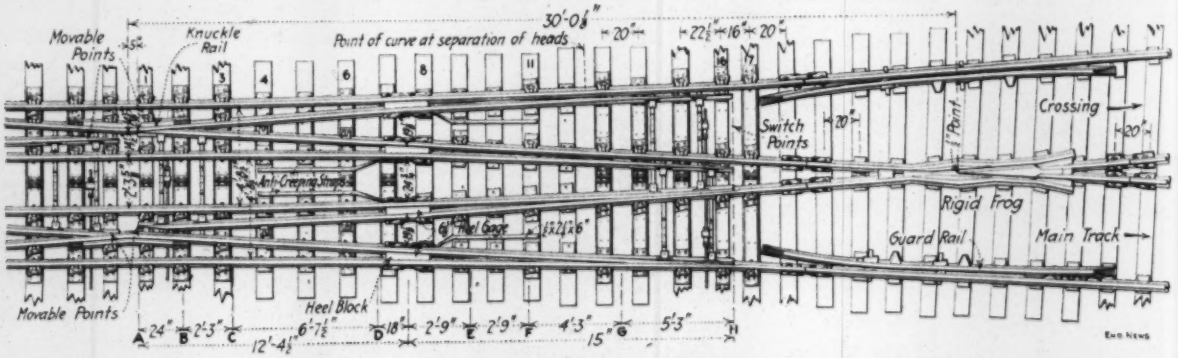

FIG. 1. NEW DESIGN OF DOUBLE SLIP-SWITCH CROSSING, PENNSYLVANIA R.R.

The switch rails are subjected to very severe usage, and each switch point rail is reinforced on each side by a strap riveted to the web, with rivets about 8 in. apart. The strap on the gage side is ½x2¼ in., 13 ft. 5 in. long; that on the stock-rail side is ⅜x2¼ in., 11 ft. 2 in. long. All switch-point rails have stops about 9 ft. 6 in. from the point (to bear against the stock rail when the switch is thrown), and the curve-point rails have stops also at about 2 ft. from the heel.

The switch rails and movable frog-point rails are raised somewhat above the level of the stock rails (as in ordinary switch construction) in order to provide free movement for worn or false-flanged wheels. The arrangement in this case is as follows, the letters on the plan (Fig. 1) indicating the positions:

(*A*-*B*)—Movable-point rail planed to rise from ⅝ in. below top of stock rail at (*A*) to $\frac{5}{16}$ in. above it at (*B*).

(*B*-*C*)—Movable-point rail level but $\frac{5}{16}$ in. above stock rail.

(*C*-*D*)—Movable-point rail drops from $\frac{5}{16}$ in. above stock rail at (*C*) to be level with it at (*D*).

(*D*-*E*)—Switch-point rails level with stock rails.

(*E-F*)—Switch-point rails rise to $\frac{5}{16}$ in. above stock rail at (*F*).

(*F-G*)—Switch-point rails level but $\frac{5}{16}$ in. above top of stock rail.

(*G-H*)—Switch-point rails planed down from $\frac{5}{16}$ in. above top of stock rail at (*G*) to $\frac{5}{8}$ in. below it at (*H*).

An ordinary movable-point double-slip crossing consists of the two intersecting tracks, two rigid frogs at the ends of the "diamond" formed by the intersection, the movable-point frogs at the middle, and the curved switches of the slips which enable a car or train to

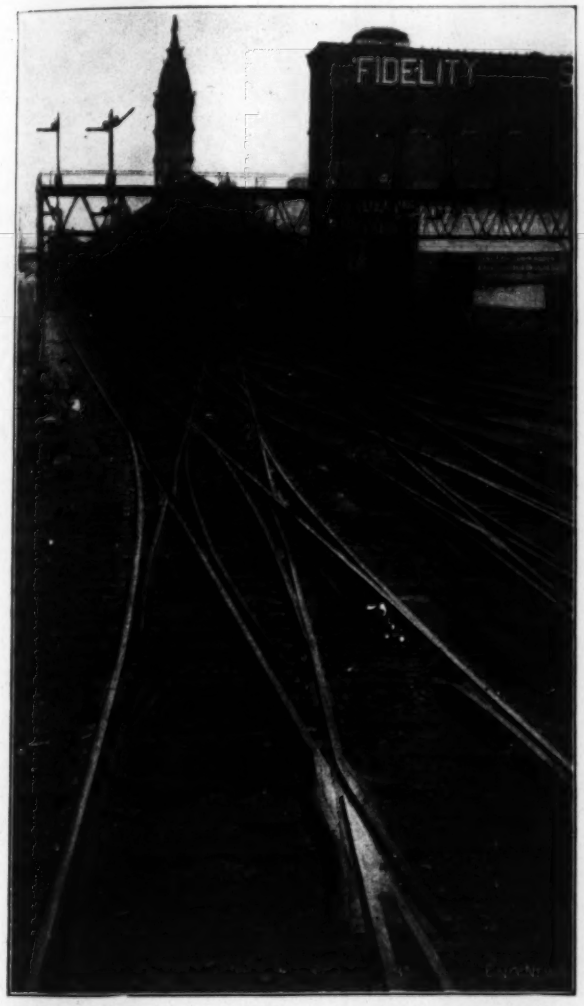

FIG. 2. DOUBLE-LADDER TRACK IN THE BROAD ST. STATION YARD AT PHILADELPHIA, PENN., WITH DOUBLE-SLIP CROSSINGS AT EACH INTERSECTION; PENNSYLVANIA R.R.

"slip" from the diagonal track to the running track, or the reverse. These switches are within the diamond of the crossing. Besides these, there are the outside knuckle rails which connect the switches through the running track. Supplementary to these parts are the stock and connecting rails with their bolts and fastenings. In addition there are the numerous bridle plates and rail braces to maintain the running parts in proper surface and alignment and in proper position relative to each other.

In a description prepared for our use, it is pointed out that in calculating a single or double movable-point slip-crossing, so as to give the smallest possible degree of curve, there are two conditions to be met: (1) the smallest possible switch angle, which is practically the key to all slip switches; (2) the inside switch points must be curved back of the separation of the heads of the stock and switch rails, so as to give the longest practicable radius of curvature. The slip proper can be started in the toe of the frog, where there is a 15-in. spread. The value of the greater radius of curve and of the other features is obvious. They not only make an easier riding layout, but reduce the wear and tear on both track and rolling stock, and also greatly reduce the liability to derailment.

The maintenance of surface and alignment of track is a difficult matter in complicated layouts of this character, and in slip crossings the alignment can be maintained to the best advantage by means of bridle plates and rail braces at all important points. These plates are long steel tie-plates, most of them extending practically the full length of the tie, and of sufficient width and thickness to stand the strain of traffic without being distorted or cutting into the ties. They are secured to the ties by lag screws, and the ends of the plates are bent over and flattened down on top, so as to form a broad

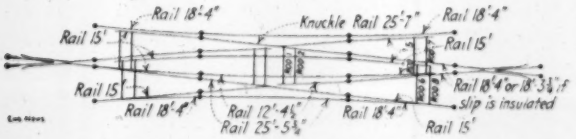

FIG. 3. DIAGRAM OF DOUBLE-SLIP CROSSINGS AT INTERSECTION OF LADDER TRACK AND MAIN TRACK

shoulder. The edge of this shoulder is planed to fit against the base of rail in some places and the back of the adjustable rail brace in others. Each brace is held to the plate by two $\frac{7}{8}$-in. bolts with double nuts.

For the inner rails, corresponding shoulders may be formed by riveting upon the bridle plate a $\frac{3}{8}$-in. plate, 3x7½ in., or where there is no bridle plate a tie-plate is used of sufficient size and thickness to carry the rail and allow of planing in the plate a channel to receive either the rail, in some places, or in other places the rail and its brace. The necessary riser plates to carry the switch rails slightly above the stock rails (so as to clear worn wheels with false flanges) are also riveted upon the bridle plates. For insulated slips, the bridle plates (9 to 10 ft. in length) are made in two sections, with the inner ends bent up and bolted together to form a flange joint, a strip of insulating material being fitted between the flanges. Typical plates are shown in Fig. 4.

The adjustable rail braces on the bridle plates are an important feature of the track work, as they afford the necessary support to the stock rails and make it an easy matter to bring the rails to exact gage when they have become worn. The adjustment is affected by making the contact faces of the brace and lug at a slight angle with the rail, so that when the brace is driven forward it forces the rail inward. When thus adjusted and secured the bridle plate maintains the parts in position. The plates cannot shift, as they are secured to the ties independently of the rail fastenings. The rail braces being thus securely held and being mounted on steel

plates instead of upon the wood ties, hold the rails in exact position. They prevent the rails from shifting and also prevent them from bending or twisting in the web. Other details are shown in Fig. 5.

By using the cast-steel heel-blocks at all switches, it becomes easy to maintain the proper spread and gage at the heel. At the heel end of each switch also there is an

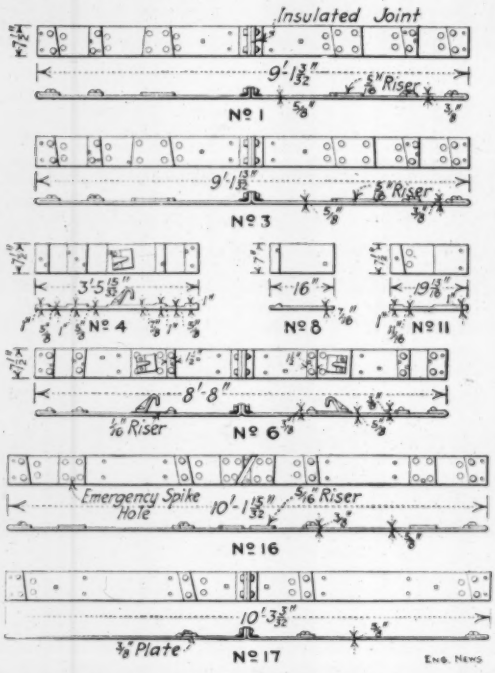

FIG. 4. BRIDLE PLATES AND ATTACHMENTS FOR SLIP-SWITCH CROSSINGS; PENNSYLVANIA R.R.

anti-creeper device. This consists of a strap ½x2¼ in., 6 ft. long, having one end held to the rail by the joint bolts, while the other extends over and upon three ties and is fastened to each of them with two lag screws. This prevents the switch points from creeping, and assists in the maintenance of proper alignment of the switches. All the switch rods, whether on switch points or on movable-point frogs, are extended so that they project about 6 in. under the stock rails. This prevents the point rails from rising when trains are passing over the crossing.

The two No. 8 rigid frogs used are of the reinforced type, having manganese-steel castings for the points and the throat. The knuckles at the movable-point frogs are of rolled manganese steel, and the easer rails are of openhearth steel.

The following is a list of the parts included in the No. 8 crossing (Fig. 1), exclusive of the various bolts, nuts and washers for fitting the parts together. To insure accuracy in the installation, all parts are required to be marked in accordance with numbers and letters shown on the plans:

2 No. 8 manganese hard-center rigid frogs	8 heel blocks
2 manganese-steel knuckle rails (with easer rails)	8 anti-creeping straps
4 movable-point rails	80 adjustable braces
8 switch-point rails	12 switch rods
12 connecting rails	4 guard rails
68 switch plates	24 splice bars
	40 tie plates
	344 screw spikes

The Pennsylvania R.R. has within the last 18 months installed at different points on its system about 30 of these slip crossings of different frog numbers and a considerable number have been ordered and are being constructed. The reports upon the behavior of the crossings already in service have been uniformly favorable. In one or two instances where the local conditions have made the service unusually severe, the crossing has performed its functions without any unusual repairs and very little attention, and it is thought that this design of slip crossing will prove an important source of economy in this feature of track work.

The first set of the new slip switches in the Broad St. station yard was installed in one of the main inbound and outbound tracks, over which there are approximately 300 regular train and shifting movements daily. This set was installed in March, 1912. In May, 1913, one switch point out of the total of eight involved was removed on account of being flange worn, while during the 14-months' service the slips had been surfaced three times (for low joints, etc.). With the old form of layout, probably three switch points would have been renewed in the same time (owing to the sharper curve), and there would have been a general overhauling about every six weeks for gage, line and surface. In this yard there are 22 No. 8 slips, and 18 No. 10 slips.

Before being installed the work was laid out and assembled in the yard, so that the men would be familiar with it. The track was given over for renewal about

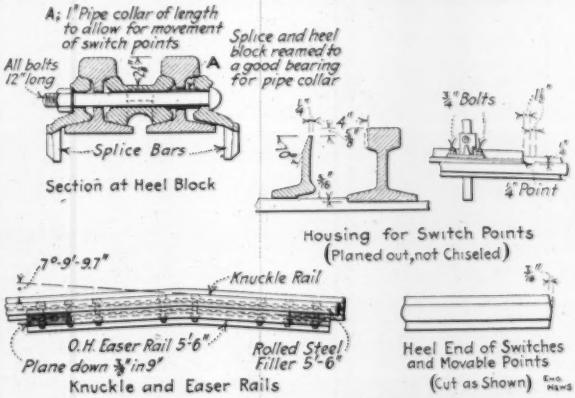
A; 1" Pipe collar of length to allow for movement of switch points
Splice and heel block reamed to a good bearing for pipe collar
All bolts 12" long
A
Splice Bars
Section at Heel Block
3/4" Bolts
1/4" Point
Housing for Switch Points
(Planed out, not Chiseled)
7°-9'-9.7"
Knuckle Rail
O.H. Easer Rail 5'-6"
Rolled Steel Filler 5'-6"
Plane down 3/8" in 9"
Knuckle and Easer Rails
Heel End of Switches and Movable Points
(Cut as Shown)
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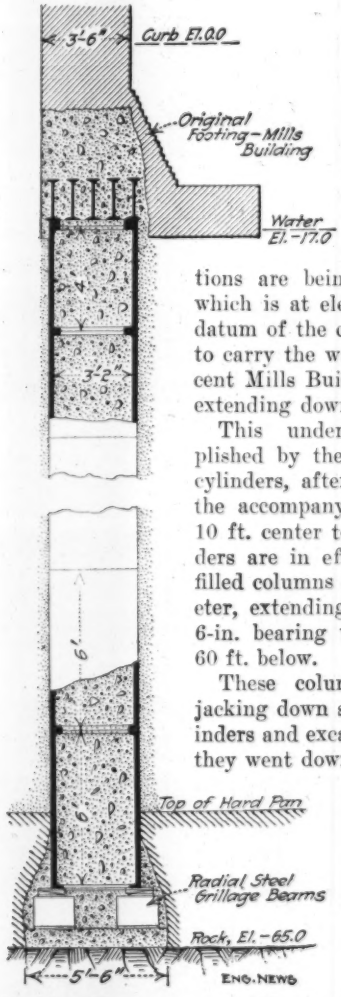
FIG. 5. DETAILS OF DOUBLE-SLIP CROSSINGS; PENNSYLVANIA R.R.

7:45 on a Sunday morning, and by 3 p.m. it was again ready for service. This was done with a gang of 28 men, of whom two were flagmen. Owing to the difference in the layouts of the old and new slips the work could not be done piecemeal, but the old layout had to be taken out entirely before installing the new work.

Asphalt pavement repairs may be made on a new plan by the city of Philadelphia. The Bureau of Highways of this city, of which Mr. Wm. H. Connell is Chief, recently opened bids for asphalt repairs on alternative plans, one the ordinary plan, so much per square yard and the other, bds based on the tonnage of asphalt material used. The bids received were as follows: Per square yard of asphalt repaired and resurfaced, Barber Co., $1.22; Union Paving & Construction Co., $1.40; Eastern Paving & Construction Co., $1.72. For asphalt binder used per ton: Barber, $4; Eastern, $11; Union, $11.50. Asphalt wearing surface per ton; Barber, $9; Eastern, $15; Union, $16.50. It is estimated that 6200 tons of binder and 10,000 tons of resurfacing material will be required during the current year.

Underpinning the Old Mills Building, Broad and Nassau Streets, New York City

The banking firm of J. P. Morgan & Co. is now building on the corner of Broad and Nassau Sts., New York City, a new building on the site of their old offices in the Drexel Building. The building is adjoined on two sides by the Mills Building, an eleven-story bearing-wall structure with extremely heavy footing walls carrying a 3-ft. 6-in. bearing wall at the curb level. The new Morgan Building will be only four stories in height, but the foundations are being placed to carry a much greater load in case the future demands a taller building on the site. For that reason the foundations are being carried to bedrock, which is at elevation —65 below the datum of the curb. It was necessary to carry the walls of the heavy adjacent Mills Building on underpinning extending down to this bedrock level.



TYPICAL UNDERPINNING COLUMN UNDER MILLS BLDG. IN CONSTRUCTION OF MORGAN BUILDING, NEW YORK CITY

This underpinning was accomplished by the use of 19 pneumatic cylinders, after the design shown in the accompanying cut, spaced about 10 ft. center to center. These cylinders are in effect cast-iron concrete-filled columns 3 ft. 2 in. inside diameter, extending from under the 3-ft. 6-in. bearing wall to bedrock, about 60 ft. below.

These columns were formed by jacking down successive cast-iron cylinders and excavating the material, as they went down, in compressed air to keep out the water, which has a normal elevation about 17 ft. below curb. The cylinders used are 3 ft. 2 in. inside diameter and, except for the bottom two, 4 ft. in length. The bottom two cylinders are each 6 ft. in length and are used, the bottom one for the working chamber and the next to bottom one for the air lock. They are all provided with flanges which are bolted together as they are forced down into the ground.

An unusual feature in the underpinning is the spread footing given at the base of the columns. The weight of the Mills Building is about 40 tons per lin.ft. so that it was thought wise to enlarge the base to give a larger bearing area on the rock. This was done by spreading out the opening from hardpan down to bedrock to a maximum diameter of about 5 ft. 6 in. and setting the lowest cast-iron cylinder on radially placed steel-grillage beams footing into concrete leveled across the rock bottom. The bottom cylinder was wedged tight against the steel-grillage beams by use of steel wedges. The whole column was then filled in with concret to the base of the original wall, large grillage beams about 7 ft. long being placed across the top of the cast-iron concrete-filled cylinder to strengthen the footing there.

The main caissons for the support of the Morgan Building are now being constructed. They average in plan about 7x28 ft. and will be placed end to end entirely surrounding the lot. They will be carried to bedrock, as stated, about 35 ft. below Wall St. and the adjoining ends keyed together. The center of the lot will then be excavated about 55 ft. below the street, forming a water-tight cellar.

The entire foundation work for the Morgan Building, including both the underpinning columns noted and the final foundation caissons noted here, is being carried out by The Foundation Co., 115 Broadway, New York City.

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A Suburban Metropolitan District, consisting of the territory within 25 miles of the city limits of Philadelphia, was created by an Act of the Pennsylvana Legislature, which adjourned early in July. The Act provides that any city, borough or township, partly or wholly within 25 miles of a city of the first class, shall be regarded as within the urban metropolitan district for the purpose of coöperation between the suburban districts and the city of the first class. The Governor is to appoint a Suburban Metropolitan Planning Commission, consisting of 15 members, 12 of whom shall lie within the suburban metropolitan district, and three within the city of the first class. The duties and powers of the Commission are stated in the Act as follows:

Sec. 4. The Suburban Metropolitan Planning Commission shall make, or cause to be made, and laid before the respective governmental authorities of the district, and, in its discretion, cause to be published, a map or maps of the entire district, or any portion or portions thereof, showing any or all systems of transportation, highways and roads, parks, parkways, water-supply, sewerage and sewage disposal, collection and disposal of garbage, housing, sanitation, playgrounds and civic centers, or of other natural physical features of the district; and it shall prepare plans for any new or enlarged facilities for intercommunication, parks, parkways, water-supply systems, sewers, sewage disposal, garbage disposal, land plottings and housing arrangements, playgrounds and civic centers, or any other public improvement that will affect the character of the district as a whole, or more than one political unit within the district, or any widening, extension or relocation of the same, or any change in the existing township or borough or city plans, by it deemed advisable. And it shall make recommendations to the respective governmental authorities, from time to time, concerning any such matters or things aforesaid, for action by the respective legislative, administrative or governmental bodies thereon; and in so doing have regard for the present conditions and future needs and growth of the district, and the distribution and relative location of all the principal and other streets, and railways, waterways, and all other means of public travel and business communications, as well as the distribution and relative location of all public buildings, public grounds, and open spaces devoted to public use, and the planning, subdivision and laying out for urban uses of private grounds brought into the market from time to time.

Sec. 5. Any city, borough, or township, within any Suburban Metropolitan District, may request the Suburban Metropolitan Planning Commission of that district to prepare plans concerning any of the subjects set forth in section four of this act; whereupon it shall be the duty of the Commission to prepare such plans with dispatch.

Sec. 6. The Suburban Metropolitan Planning Commission may make recommendations to any public authorities, or any corporation or individual in said district, with reference to the location of any buildings and structures to be constructed by them.

Sec. 7. The plans so made and laid before the respective governmental authorities by the Suburban Metropolitan District Planning Commission, according to Sec. 4, 5 and 6, shall be considered by such respective authorities, and followed by them in so far shall be determined by each authority:

The expenses of the Urban Metropolitan Planning Commission are to be determined by a yearly estimate, made by the Commission, and are to be proportioned by the Commission among the local governing bodies included within the district, in proportion to their respective taxable values. The rate of assessment, however, is limited to one-tenth of one mill on the assessed valuation.

The Guaranty Trust Company's New Building, New York City

By Eugene W. Stern*

In the construction of the new building for the Guaranty Trust Co., at Broadway and Liberty St., New York City, just completed under York & Sawyer, architects, some rather interesting problems in the foundations and steel construction required solution. A brief description may be of interest to readers of Engineering News.

General Description

The building is monumental in character. The facades are of granite in the classical style, the order being 45 ft. high. Although the building has only eight stories, it is about 162 ft. high from curb to the top of the roof.

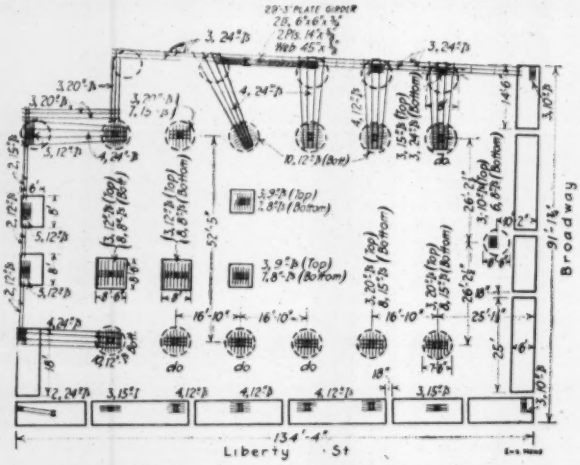


Fig. 1. Foundation and Footing Plans

The first story is unusually high, the distance from the first to second floor being 56 ft. 10 in. In the first, second and third stories, the central spans over the large banking room are quite wide, being 52 ft. 5 in., spanned by plate-girders 34 in. deep. In the height of the sixth story, there are heavy trusses supporting by hangers the fourth and fifth floors, and by uprights the eighth floor, attic and roof.

There is a basement and sub-basement, in which is a very large two-story bank vault extending from the sub-basement floor to the under side of the first floor. It contains about 6000 lin.ft. of shelf space, and is supposed to be the strongest and most burglarproof safe in existence.

Foundations

Above the level of the groundwater, which is about 26½ ft. below curb, the soil is fairly coarse sand. Below this it is a fine quicksand or silt, all the way down to hardpan, which is from 70 ft. to 75 ft. below curb. This hardpan varies from 2 ft. to 6 ft. in thickness, and under it was found the usual bedrock common to New York—a good quality of gneiss.

Ordinarily a building of this height might safely be carried by spread footings on the soil. In fact, the old building which stood on this lot, eight stories high, built in 1864, with heavy masonry exterior walls, was founded on the soil, and showed not a sign of settlement of the footings, although the soil was loaded to about 3 tons per sq.ft. The record of the old building complicated the design of foundations of the new building, for it created a presumption that the slightly higher intensity of loading from the new building could also be carried safely on spread footings.

The extra cost of carrying foundations to rock—about $150,000—seemed to be an unnecessary expense when the half century of satisfactory service of spread footings in the old building was contemplated. However, there were various special conditions bearing on the question of foundations for the new building, of such character as to render the employment of soil foundation very questionable, or hazardous. When the arguments on this score were marshaled complete, they proved fully persuasive in favor of rock foundation. Therefore, the decision was reached to sink compressed-air caissons to

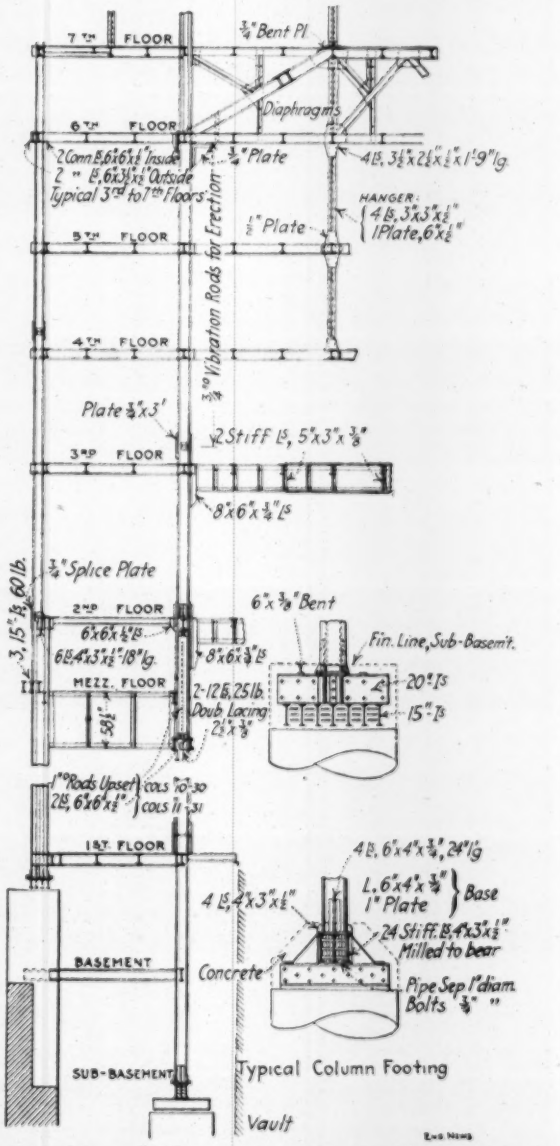


Fig. 2. Vertical Cross-Section, North-South, of the New Guaranty Trust Bldg., Broadway and Liberty Sts., N. Y. City

*Consulting Engineer, 101 Park Ave., New York City.

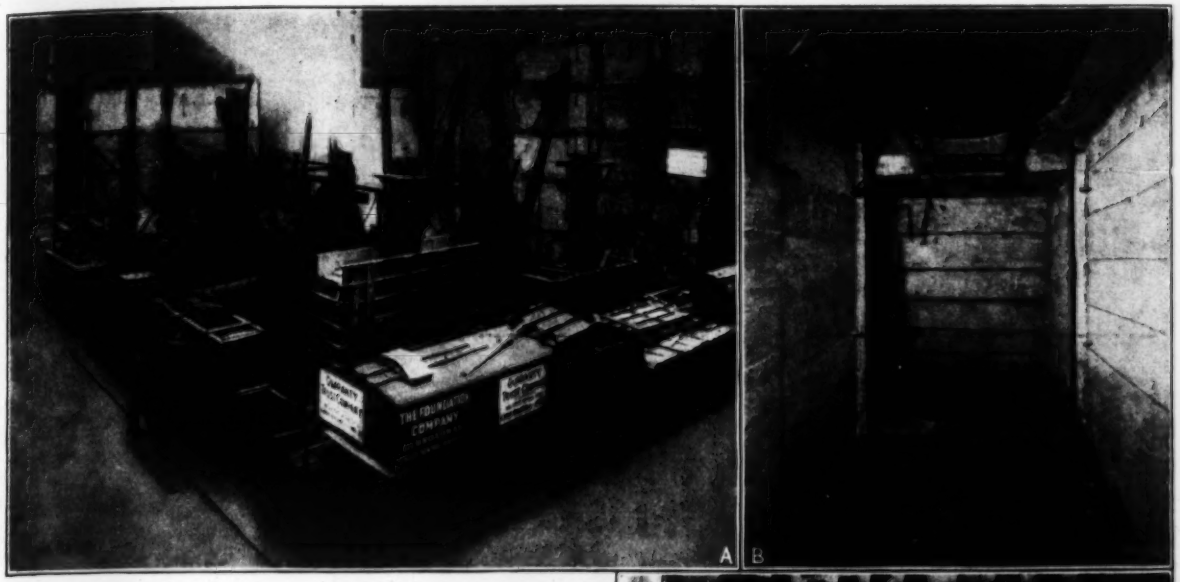


FIG. 3. CAISSON SINKING FOR FOUNDATIONS OF GUARANTY TRUST CO. BUILDING, NEW YORK CITY

(A) General view of foundation work, Nov. 13, 1911.
(B) Working-chamber of a reinforced-concrete caisson (NW. corner caisson).
(C) Cast-iron weights on caisson to force it down (at middle of north or Liberty St. wall).

rock for practically all of the foundation; only a few lightly loaded subsidiary columns in the interior were founded on the soil, and these are protected against the hazards mentioned, by the inclosing wall of caissons.

The considerations which were decisive in choice of foundations were:

(1) If it were attempted to spread the foundations as much as is economically possible, on the top soil, the minimum pressure on the foundations under the Broadway facade would amount to about 4¾ tons per sq.ft., and under the Liberty St. facade to about 3¾ tons per sq.ft., which was considered excessive for the kind of soil and the conditions existing under this building, three tons being considered all that could be safely placed upon it.

(2) The above pressures could not be economically reduced by any system of cantilevering, owing to the fact that the Bureau of Buildings will not allow a foundation to project over the lot lines onto city property by even so much as an inch, and also to the fact that there are practically no interior columns in the building, due to the large spans over the banking rooms, to act as counterbalances in distributing the pressures of cantilevers. The heavy masonry facades of the building complicated this problem.

(3) If, for the sake of argument, it were deemed safe to place the foundations on the top soil with pressures as above noted, there was another and very important reason why these foundations should be carried down to solid rock or good hardpan, viz., the fact that a rapid-transit subway in Liberty St. was authorized in 1905. If ever constructed (and there was a strong probability that it would be when this question was under discussion) it would have to be carried under the present Broadway subway, and, therefore, its bottom would be well below water level, and there would during its construction of necessity be some settlement of adjoining buildings, regardless of whatever precautions might be taken to prevent this. A monumental building, such as that proposed for the Guaranty Trust Co., would be an extremely difficult one to protect against settlement, and the work of doing this would involve a great deal of temporary inconvenience, and considerable annoyance, to the occupants of the building.

(4) There would always be the strong probability of high modern buildings on deep foundations being constructed on Liberty St., both directly adjoining on the east and right opposite to the north, with the same possibility of disturbance to the foundations of adjoining buildings as would happen in the construction of a subway.

It was therefore decided to carry all the foundations of the building proper down to rock or hardpan, building a continuous retaining-wall along Broadway and Liberty St., by sealing the caissons together so as to prevent seepage of the subsoil along the street fronts. Some of the minor interior foundations, such as those supporting only the first floor, interior partitions and bank vault, were carried on the soil, above water level, at a pressure not exceeding 2 tons per sq.ft. The locations of the caissons are indicated in the plan, Fig. 1.

Rectangular Caissons—The rectangular caissons, including the working chambers, were entirely of reinforced concrete, no wood whatever being left in the permanent work. They varied in size from 6x8 ft. to 6x25 ft.

The steel reinforcing in the working chamber con-

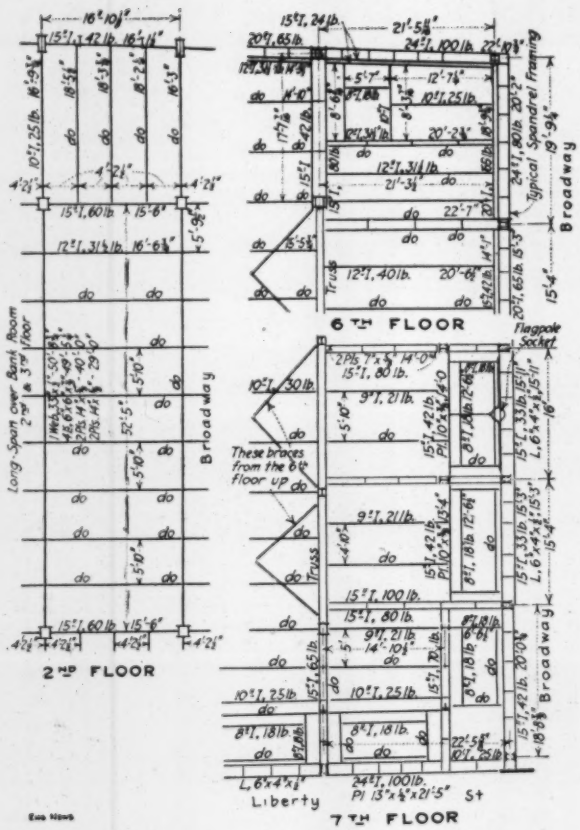


FIG. 4. PART PLAN OF FRAMING SECOND, SIXTH AND SEVENTH FLOORS, GUARANTY TRUST CO. BUILDING

sisted of: two vertical lines of 1-in. round rods spaced about 12 in. apart, 4 in. in from faces of the 10-in. concrete wall, and two horizontal lines of ¾-in. round rods spaced about 8 in. apart, just outside of the vertical rods. In the pier above the working chamber the reinforcement consisted of: 1-in. square bars vertically spaced about 2 ft. apart and set in 3 in. from the outer face, and 1-in. square bars horizontally, spaced 4 ft. apart, just inside of the vertical rods. The concrete immediately around the working shafts was reinforced with ⅞-in. round hoops, spaced about 12 in. vertically, to take up the bursting strain due to air pressure.

The inner forms for these shafts were of cast iron, made collapsible, in lengths of about 20 ft. The outer forms were removable, and were made of 1½-in. tongue-and-grooved plank stiffened with angles.

Circular Caissons—The circular caissons had steel working chambers made of ⅜-in. plate stiffened with angles; above the working chambers they were built of concrete, reinforced with vertical lines of 1⅛-in. round rods 2 ft. apart, placed 4 in. from the outside face, and horizontal hoops 6 in. outside the working shaft as in the rectangular caissons.

The outer forms were of ¼-in. steel, and removable. The inner forms were collapsible cast-iron sections similar to those used in the rectangular caissons.

The speed of sinking the caissons was about 6 in. per hour in the quicksand after air was turned on.

Caisson Joints—The joints between the rectangular caissons forming the sections of the rim were made under compressed air. Vertical chases cored out of concrete in the ends of the sections formed octagonal shafts about 3 ft. in diameter between adjoining sections. An air lock was set in a concrete deck formed near the top of each of these shafts, and the shaft excavated and filled with concrete under compressed-air protection.

The sealing of the working chambers was effected by first carrying up the concrete in these to within about a foot of the roof, being careful to see that the 3-in. air pipes were not stopped up, so that no air pockets could form. After this concrete had hardened, the air was taken off, and the lock removed. Liquid grout consisting of equal parts of cement and sand was then dumped down the working shaft. The pressure of this liquid grout caused it to rise about 10 ft. in the air pipes.

Waterproofing—The level of groundwater is about 6 ft. higher than mean high tide in the river, varying from

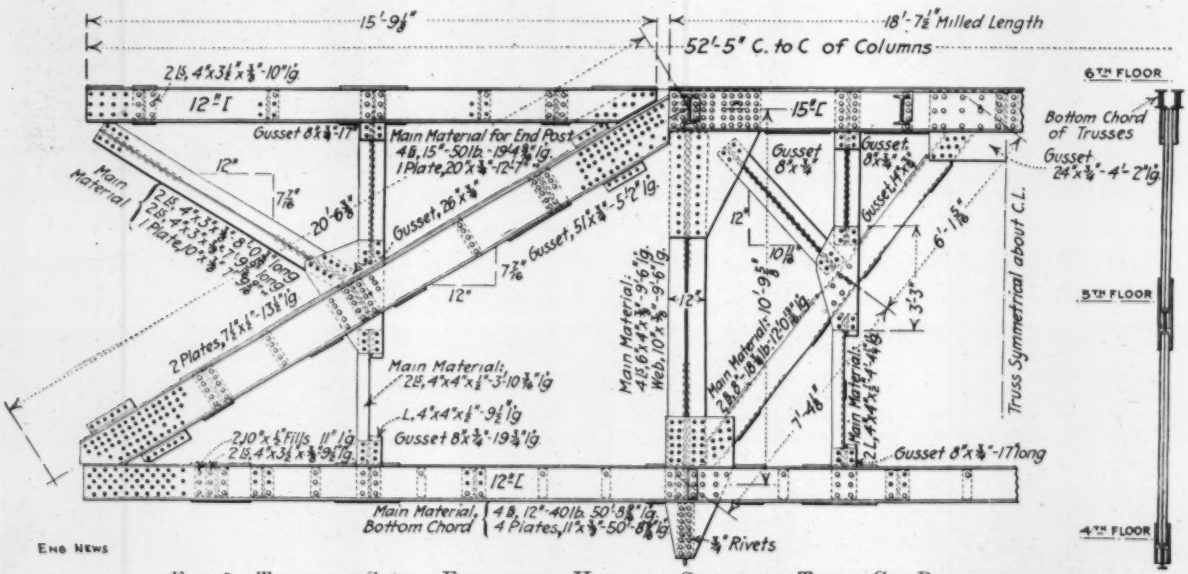


FIG. 5. TRUSS AT SIXTH FLOOR, AND HANGER; GUARANTY TRUST CO. BUILDING

26½ to 28½ ft. below curb level at Broadway and Liberty St. After the Equitable fire it rose over 2 ft. in the lot, owing to the flooding of the cellar of the Equitable, although it is 100 ft. away. While the cellar bottom is above high-water mark, nevertheless all walls and floors up to the street level were waterproofed with Hydrolithic cement, applied to the surface of the concrete.

Superstructure

The front walls of the building are practically self-supporting up to the sixth floor, above which they are carried on the columns by steel girders. In the rear the brick walls are of skeleton construction, being carried at every floor.

The first story being 56 ft. 10 in. high, the columns have an unsupported length of 40 ft. This unusual length called for a special design of column for stiffness. They are box columns, those in the walls being 24-in. built channels with 16-in. coverplates, while those standing free are 15-in. channels with 22-in. coverplates. The length-ratio l/r is not over 70. Horizontal diaphragms were used in the interior of each column, spaced 6 ft. apart vertically.

The four granite columns in the first story of the Broadway facade are structural columns, inasmuch as they support the steel columns above; each carries a load of 325 tons at the top. They are 45 ft. high by 5 ft. 6 in. in diameter at the bottom.

Owing to the very few columns in the building, due to the wide span of 52 ft. 5 in. in the first, second and third floors, the great height of the first story, and the fact that the fourth and fifth floors are hung from trusses between the sixth and seventh floors, much thought was given to the problem of bracing the steelwork of the building, so that it would be stiff both during erection and after completion. The nature of the soil overlying the rock in this part of the city—a fine quicksand—is such that tremors due to the trains in the subway might be transmitted into the building even though all the foundations are carried down to rock.

The scheme of bracing was developed in the following manner:

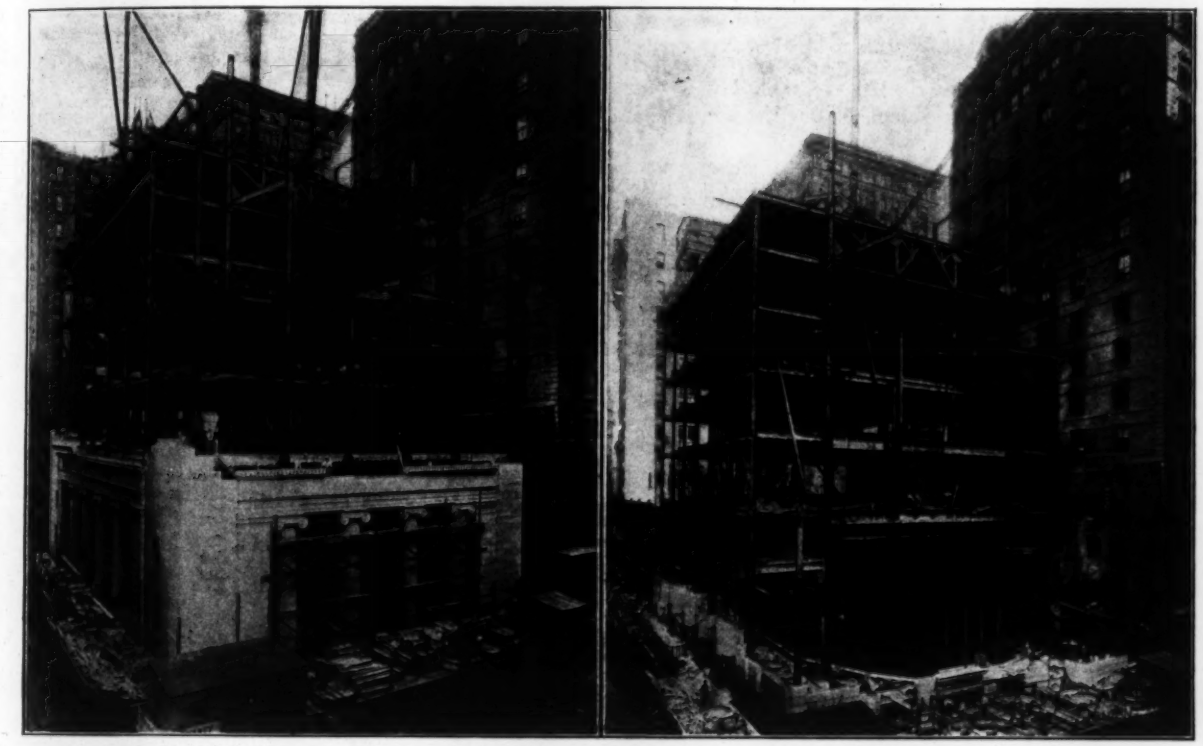
(1) Deep plate-girders running north and south, in the mezzanine floor between first and second floors, connect the wall columns to the interior columns, with stiff riveted column connections. In conjunction with these girders, latticed struts running east and west between columns reduce their unsupported length.

(2) Lateral bracing in the fourth and fifth floors, and between the chords of trusses in the sixth and seventh floors, makes the entire cross-section of the building act as a unit.

(3) The 15-in. girder beams in the fourth and fifth floors between columns 14 to 34 are made continuous through the hangers.

(4) In the third to seventh floors, the north-south girders are made double, so that they straddle the columns, and have stiff web-connections to these columns.

Trusses—The trusses carry a load of about 500 tons each. They have full riveted joints throughout, no allowances whatever being made for the bearing value of the joints in the compression members. The holes in the



Part of Stone Face Walls Erected, and Four Wall Columns of Broadway Front Supported on Stone Columns.

Steel Frame Partly Erected, Showing Large Span over Bank Room, and Truss in Sixth Story for Carrying All Floors from Fourth to Roof.

Fig. 6. Erection of Guaranty Trust Co. Building, Liberty St. and Broadway, New York City

trusses were punched 1/8 in. less in diameter than the rivet, were then assembled complete in the shop, carefully fitted, and all holes reamed 1/16 in. The joints were then match-marked before being taken apart, so as to insure the right pieces coming together during erection. This precaution was amply justified by the fact that the members of the trusses fitted perfectly in the field, and were erected without the slightest difficulty.

Steel diaphragms connecting the different parts of the compression members were used plentifully throughout.

Provision is made for three door openings in each of the trusses. To accommodate the large opening in the middle, the adjacent web members were spread apart, making an eccentric joint, which, however, is of no importance under uniform load.

The design and construction of the bank vault in the building are described in the article following.

Erection—The erection plant consisted of one 8-ton steel guy-derrick with 75-ft. boom, run by a 25-hp. electric hoist, and one 15-ton steel guy-derrick with 65-ft. boom, run by a 75-hp. electric hoist. All field rivets were driven by pneumatic hammers.

The shop work was excellent, likewise the erection. The setting was done so accurately at the building that the long first-story columns plumbed within 1/4 in.

The builders were Marc Eidlitz & Son. The subcontractor for the steelwork was Post & McCord; for the foundations, The Foundation Co.

The steelwork was inspected at the shops by R. W. Hunt & Co. The caisson work was inspected by T. K. Thomson.

Daniel E. Moran was Consulting Engineer for the builders on the foundations, and the writer was Consulting Engineer for the architects on the steelwork and foundations.

❖

The Arbitration of Differences between the City of Cleveland and the Cleveland Ry. Co. arising out of interpretation of the ordinances under which the company operates (see "Engineering News," of Mar. 10, 1910, and Sept. 19, 1912) has been completed and the report of the arbitrators was presented on June 19 last. The first question which they answered was the one "Has the railway company a legal right to maintain other reserves than those specifically provided for in the amended ordinance?" The arbitrators were unanimously of the opinion that an insurance reserve against the hazards of accidents, etc., is not sustainable although dictated by safe business policy under ordinary franchises. It was held that the franchise agreement with the city contains clauses which allowed the cost of accidents, etc., to be met out of general funds and recouped if necessary by increasing the rate of fares.

A second very important question was, "Has the company a legal right to exceed the allowance for operation and maintenance and renewal stipulated in the amended ordinance without the consent of the city or the award of a board of arbitration?" The arbitrators find that the officers must regard the ordinance limitations on their expenditures, except where emergencies arise or conditions come about which were clearly and reasonably not known when the allowance was fixed. When such a situation comes to pass, a demand for expenditure beyond the allowance must be charged against the city and diligence in warning the city of the items in which increase is being met with entitles it for a retroactive allowance to make good a deficit. The commission further approves of increasing the allowance for operating expenses from the ordinance figure 11.5c. to 12.1c. per car-mile on account of the present increased cost of labor, etc. It also recommended that for the sake of getting a clean slate in the operation of the railroad and for the elimination of friction between the city and company that the City Council should authorize the transfer from the general interest funds to the operating and maintenance funds sufficient money to balance all over-expenditures out of those funds. The Board of Arbitration consisted of Judge J. M. Killits, C. M. Duffy and A. B. duPont.

Bank Vault of the Guaranty Trust Company of New York City

The new building of the Guaranty Trust Co., Broadway and Liberty St., New York City, contains in its basement and sub-basement stories a security vault of unusual size. Its builders believe it to be burglarproof and fireproof in the highest degree, and the engineer states that it is excelled by no other bank vault in these respects. Its outside dimensions are 39 ft. 5 in. x 28 ft. 6 in., by 28 ft. 5 in. high; its inside clear dimensions are 34 ft. 7 in. x 23 ft. 8 in., by 21 ft. 1 in. high. Structurally the vault is a 24-in. shell of concrete with embedded steel rails, and a 4-in. lining of chrome-steel and bessemer steel plates. The inside is divided into two stories, each about 10 1/4 ft. high, with separate safe doors. The vault has about 6000 lin.ft. of shelf room. Its total weight, empty, is about 1750 tons; at 2000 lb. per sq.ft. live-load, its maximum loaded weight is about 3400 tons.

Foundation

While the building itself is carried on concrete piers sunk to rock by means of pneumatic caissons, the vault is founded on the soil (sand) at the bottom of the cellar excavation. The loading on the soil ranges from 2 tons per square foot (vault empty) to about 3 or 4 tons per square foot (vault loaded). The vault is set in a pit 5 ft. deep below the sub-basement floor (which brings the vault floor flush with the sub-basement floor) and rests on the concrete flooring of the pit.

The weight of side walls and roof forms a large part of the total vault weight; further, the side-wall loading is increased by the two great doors in the east wall, and by the first-floor live-load directly over the vault and for a 3 1/2-ft. width on either side—all this area being carried by the vault. Thus, some 1500 tons of load reach the footing level on the line of the walls. The footing distributes this load over the full foundation area by beam and rail grillages.

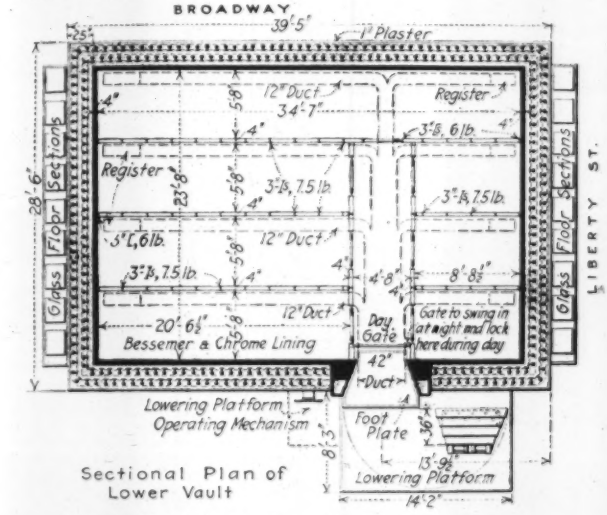
The vault is rectangular in plan, and its long direction is placed transverse to the building, parallel to the Broadway front. The pit floor, 12 in. of concrete, carries eight pairs of 18-in. 70-lb. I-beams extending north to south, from out to out of the end walls of the vault. The beams of each pair are about 8 in. apart, and this space is filled with concrete. The pairs are set 24 in. apart in the clear between webs; these 24-in. spaces are left open, and are provided with electric lamps and with mirrors for inspection from the floor. These eight pairs of I-beams form the principal footing grillage; the vault bottom, built directly on them, includes in its structure an east-west distributing grillage of rails, but this is at the same time an item of burglar protection.

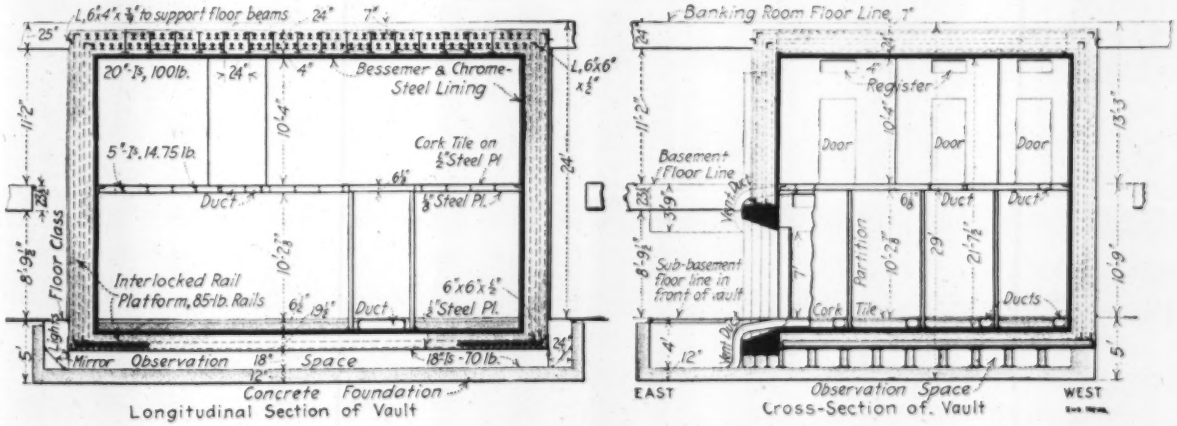
The Walls of the Vault

The vault bottom comprises: A 1/2-in. steel plate over the footing girders; an interlocked double layer of 85-lb. rails set close, alternately head up and head down, blocked up 1/2 in. from the steel plate and bedded in cement; a 13- to 14-in. thickness of concrete over the rail layer; and finally the 4-in. compound-steel lining of the vault. Inside this lining is a concrete floor-surfacing 6 1/2 in. deep which incloses the ventilating ducts for the lower story of the vault. This surfacing comprises 5

in. plain concrete, 1 in. sawdust concrete, and ½ in. cork tile.

In the side walls of the vault the grid rails embedded in the 24-in. thickness of concrete are set vertical, bases in, 8 in. apart horizontally in each of two layers (inner and outer) about 3 in. apart in the clear; at upper and lower ends they are held by 6x6x½-in. edging angles. The upper angles along the east and west sides also receive the ends of the grillage rails in the roof of the vault. These latter are set with heads up. Where their 5-in. base flnages pass between the bases of the side-wall rails (3 in. apart), the flanges are notched into each other. A good interlock of walls and roof is obtained by this means.





FIGS. 1 TO 3. PLAN AND SECTIONS OF BANK VAULT IN NEW BUILDING OF GUARANTY TRUST CO., NEW YORK CITY

The roof is similar in construction to the side walls, but in addition contains 20-in. 100-lb. I-beams spaced 24 in. apart, extending transversely across the vault (east-west). These carry the load of the vault roof and, by means of hanger-bolts, support the roof lining of the vault against any sagging tendency and provide ample resistance to shock of falling walls on other bodies in the event of fire or earthquake. The bolts, 2½ in. in diameter, screw at their upper ends into cast-steel yokes set between the I-beams, while their bottom ends engage the outer of the four layers of lining with countersunk heads. The I-beams rest at the ends on bearing-plates on the lining, directly over the side-wall lining. Thus, probably the larger part of the roof load is carried down to the foundation through the lining rather than through the concrete walls.

STEEL LINING

The steel lining of the vault comprises four plates, an outer plate of 1¼-in. bessemer steel, an inner plate of ¾-in. bessemer steel, and two intermediate plates of 1-in. chrome-steel. These are stitched together by 1¼-in. countersunk-head screws spaced 10 in. on centers, each screw penetrating only two plates. The several layers break joint 24 in. In making up the plates of the lining, the chrome-steel plates were drilled before hardening, and after hardening they were used as templates to drill the matching holes in the bessemer plates; thus perfect matching of the holes was assured in spite of the distortions caused by the hardening process. The same procedure could not be followed, of course, to match the holes of the two chrome-steel plates, but both layers were drilled to the same templates and as the changes in both of these layers were approximately the same, accurate alignment resulted.

The corners of the lining are specially formed. The corner piece in the outer bessemer-steel layer consists of a 6x6-in. angle section extending 6 ft. along each of the three corners, with the junction welded. In the next (chrome-steel) layer, the corner piece is in effect an 18x18-in. horizontal angle extending 36 in. along each of the two sides, being made from a 36x72-in. plate bent to an 18x18-in. angle, which is then mitered out in one leg of the angle, bent, and welded. In the inner chrome-steel layer a similar corner piece is used, 12 in. high (instead of 18 in.) and 24 in. long horizontally along each side. The inner bessemer-steel layer is simply butted at the corner, without a special welded junction. This corner construction is thought to be unusually strong and proof against attack.

The lower corner is utilized for bringing in the electric-light wires—the only outside service that enters the vault. A cable chamber is cored out in the bottom concrete adjacent to the outer side of the steel shell. The wires are carried into this chamber in individual conduits. From here they pass in a tortuous course through the several layers, in separate channels and holes grooved

and drilled in the plates, as follows, numbering the layers 1 to 4 from outside to inside: Inward through layer 1 along the edge of the corner angle, toward the corner along a channel cut in the inner face of the corner angle of layer 1, inward through a hole in the corner piece of layer 2, along its inner face to the farther end of the corner piece of layer 3, through a notch in the edge of this piece to layer 4 and along this layer backward and through a hole to an outlet box inside the vault.

The wires were laid in as the lining was built up, and their course obviously is such that when a wire burns out it cannot be repaired or replaced. On this account, a sufficient number of wires is provided to give an ample supply of spares for all possible contingencies.

Locks and Bolt-Work

Each entrance is equipped with 20 locking bolts 5 in. in diameter, which are operated by a bolt-throwing handle located upon the door frame and locked by two large combination locks and a four-movement time lock.

The combination locks are located upon the door frame and the time lock upon the door and afford double protection as compared with the usual practice of placing all locks upon the door, inasmuch as two holes are made necessary before the dogging mechanism can be released, one through the door and one through the door frame.

The locks are guarded against manipulation through the vault walls by a steel housing upon the inner face of the door frame and a steel plate covers the time lock and the bolt work, which is automatically clamped into position when the bolts are thrown.

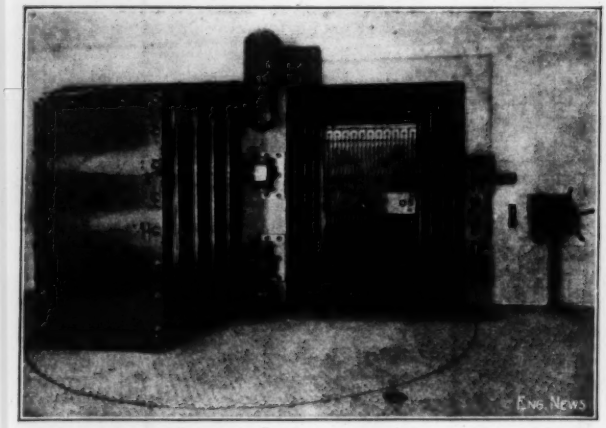


Fig. 5. Vault Door Open and Floor in Position for Use

Interior Subdivision

The interior structural equipment of the vault comprises a second floor of steel beams floored and ceiled with steel plates, and partitions of similar construction. The floor is said to be designed to support safely a load of 2000 lb. per sq.ft. It also contains the ducts for supplying ventilation to the upper story of the vault. The partitioning provides a main corridor extending inward from the door, and a number of lateral bays opening on this, each fitted with a door. Thus the interior of the vault consists of a number of isolated steel cells, lacking all possibility of natural ventilation, as might be relied upon in case of two opposite doors and a straight passage through; hence the need for a complete ventilating system.

The partitions are framed up of 3-in. I-beams and channels faced on either side with ½-in. steel plates. The floor is framed up of 5-in. I's and channels covered with a ½-in. plate on top and a ⅛-in. steel plate on the bottom.

In front of the door opening into the lower story of the vault, the foundation pit of the vault is extended outward to provide room for the swing of the vault door and to give room for a movable floor platform, by which access is obtained to the vault when the door is open. When the door is to be closed, this platform is lowered into the pit, out of the way of the swing of the door (the door extending below the floor of the vault in order to give a level unobstructed entrance).

The ventilating duct passes up in the platform pit, just in front of the door, and is turned in through the door opening. That part of the duct which crosses the threshold is carried on a section of the floor plate separate from the moving platform and hinged inside of the vault to swing in. The hinged portion is counterweighted.

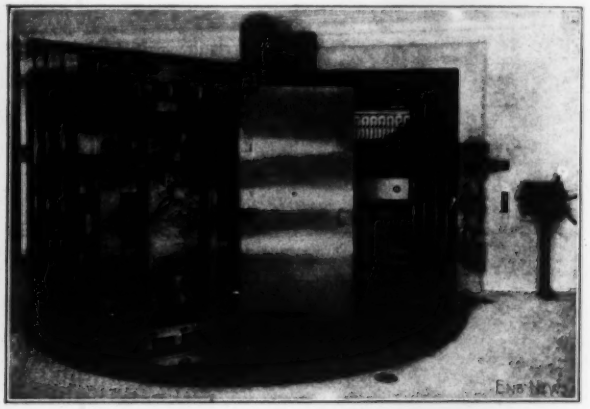


Fig. 6. Bolt System in Door Exposed

In the case of the upper door the movable platform and duct are similarly arranged, and with similar pit work.

Vault Doors

The two doors of the vault are alike. Each is 7 ft. high by 4 ft. wide inside of point steppings, and 36 in. thick and weighs about 36 tons. The door frame weighs 34 tons.

The inner half of the thickness of each door is made up of 2-in. bessemer and chrome-steel plates, alternating, screwed together. The outer face of this portion is covered with a 4-in. plate of "Feralun," extending not quite to the edges of the door. Surrounding this and forming the outer half of the door is a hollow steel casting, which is filled with concrete; a number of composite chrome-steel bars pass vertically through this concrete. The interposition of the Feralun plate between the two halves of the door is for the purpose of preventing successful attack by flame or arc, this material being found to have an extremely high resistance to attacks by such heating or fusing methods.

The door hinges are journaled in ball and roller bear-

ings of such small friction that notwithstanding its enormous weight the door can be swung easily with one hand. No power operating mechanism is provided, but hand operation is exclusively relied upon, except for the few inches of travel just at closure, which is covered by a screw pressure apparatus between the hinge yoke and the door, as shown in the photographs.

The electrical equipment on the interior of the vault consists of a complete lighting system, annunciator and alarm bell systems, and telephones.

The lights of the two main aisles are controlled by automatic switches operated by push buttons located near the entrances to each floor, and the lights of the different compartments are controlled by switches located at the entrance to each compartment.

The main aisle on each floor is furnished with a telephone instrument, directly over which is located a light that burns continuously, night and day. Should someone be inadvertently locked in the vault, the use of the telephone and the following of instructions given by the officers thus summoned would effect his release.

Erection of Vault

The erection of the vault above the foundation girders required first the construction of the floor complete, up to the lining. The steel lining was then built up, first the floor and then the side walls, the lighting wires being laid in the corner as the plates were set and screwed together. When the outer layer reached the roof of the vault the placing of the outer plate of the roof of the lining was begun, and immediately the supporting blocks were placed at the corner for the roof I-beams. The end sections of the roof plates being held on temporary supports, the I-beams were set, and then the outer two layers of the roof as fast as placed were anchored to the yokes between the girders by the 2½-in. hanger-bolts as already explained. These were adjusted to give the roof plates a camber of 1 in. The erection of the other layers of the roof lining proceeded inwards in regular order, each plate being screwed in place to the plate next outside of it.

After the lining was complete the rails of the sides and top of the vault were placed and riveted to the corner angles; on account of the interlock of side and roof rails they had to be built up together. When the entire grillage of rails was completed, outside forms were erected and the wall concrete poured. This completed the shell of the vault itself. The construction of the inner floor and the interior partitions and second floor of the vault were done last.

The vault was designed by Frederick S. Holmes, Consulting Vault Engineer, 2 Rector St., New York, and was built by the Mosler Safe Co. Its total cost was about $125,000, including doors, locks and protection, but not including interior safes.

⁂

Fan Wheels as Dynamometers have been used successfully by the Buffalo Forge Co., Buffalo, N. Y., in tests of its line of "Spiro" rotary engines, (see "Eng. News," Feb. 8, 1912). It was found (1) that in running blast wheels in open air from 200 to 260% more power was absorbed at given speed than when in a casing; (2) that with speed, barometric pressure, temperature and humidity fixed, the power input was constant and (3) that the pressure, humidity and temperature corrections were simple and direct. This company reports that any good fan wheel is suitable, after calibration with an electric-motor drive, for use as an accurate absorption dynamometer, particularly for speeds of 1000 to 5000 r.p.m.

Standard Specifications for Water-Works Hydrants and Valves*

Specifications for Hydrants

Size

Classification—The size of hydrants shall be designated by the nominal diameter of the valve opening, which must be at least 4 in. for hydrants having two 2½-in. hose nozzles; 5 in. for hydrants having three 2½-in. hose nozzles; and 6 in. for hydrants having four 2½-in. hose nozzles, and shall be classed as one-way, two-way, three-way or four-way, etc., according to the number of 2½-in. hose outlets for which they are designed.

Area Water Way—The net area of the hydrant at the smallest part, when the valve is wide open, must not be a less area than 20% in excess of the size of the valve opening.

Bell Ends or Flange Ends—All hydrants must be fitted with bell ends to fit standard cast-iron pipe, or, if flanged, they must be fitted with flanges of the standard dimensions corresponding to the pressure under which they are to be used; connecting pipe or branch from main in no case to be less in diameter than the valve opening.

General Design

Change in Diameter—Any change in diameter of the water passage through the hydrant must have easy curves, and all outlets must have rounded corners of good radius.

Water Hammer—Hydrants must be so designed, particularly as regards the pitch of the thread of the operating stem, that, when properly operated, water hammer will not be caused which will give an increased pressure to exceed the working pressure when such pressure is over 60 lb., nor increase the pressure more than 60 lb. when operated under less working pressure than 60 lb.

Strapping—Hydrants must be so designed that the leaded joint underground can be strapped.

Material

Cast Iron—All castings shall be made from a superior quality of iron, remelted in cupola or air furnace, tough and of even grain, and shall possess a tensile strength of 22,000 lb. per sq.in. The casting must be clean and perfect, without blow or sand holes or defects of any kind. No plugging or stopping of holes will be allowed.

Specimen Bars—Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made without charge as often as the engineer may direct, and in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars when placed flatwise upon supports 24 in. apart, and loaded in the center, shall support a load of 2200 lb., and show a deflection of not less than 0.35 in. before breaking; or if preferred, tensile bars shall be made which will show a breaking point of not less than 22,000 lb. per sq.in. Bars must be cast as nearly as possible to the dimensions without finishing, but corrections may be made by the engineer for variations in width and thickness, and the corrected result must conform to above requirements.

Wrought Iron—All wrought iron used shall be of the best quality of refined iron, of a tensile strength of at least 45,000 lb. per sq.in.

Composition Metals—All composition or other noncorrodible metals used to be of the best quality, to have a tensile strength of not less than 32,000 lb. per sq.in., with 15% reduction of area at breaking point.

Hose Nipples and Valves

Hose Nipples—Hose nipples must be of bronze or suitable noncorrodible metal, either threaded with a fine thread into the hydrants and securely pinned in place **or carefully locked and caulked in place.**

Hose Threads—Hose threads on all hydrants to be installed in any given community must of necessity be interchangeable with those already in service, but, where practicable, threads should conform to the National Standard.*

*In the committee report, as it will be printed by the Association, there will appear drawings and tabular dimensions of 2½, 3, 3½ and 4½-in. standard hose couplings, as adopted by the National Fire Protection Association, the various water-works associations, etc.—Ed.

Hydrant Seat and Gate

Seat—The seat must be made of bronze or suitable noncorrodible metal, securely fastened in place.

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*Adopted by the American Water-Works Association at Minneapolis, June, 1913. The specifications were drafted and submitted by the following committee: Beekman C. Little, Chairman, Morris R. Sherrerd, James H. Caldwell, Stuart Wood, J. M. Diven.

Valve—The valve must be faced with a suitable material and must be designed so that it can be easily removed for repairs without digging up the hydrant.

Drip Valve

Drip—A positively operating noncorrodible valve must be provided and arranged so as to properly drain the hydrant when the main valve is closed. The seat of the waste valve, which must be fastened in the hydrant securely, must be made of noncorrodible material. All other parts of the drip mechanism must be so designed as to be easily removed without digging up the hydrant.

Operating Parts

Operating Threads—The operating threads of the hydrant must be so arranged as to do away with the working of any iron or steel parts against iron or steel. Either the operating screw or the operating nut must be made of noncorrodible metal, and sufficiently strong to perform the work for which they are intended.

Top Nut—The stem must terminate at the top in a nut of pentagonal shape, finished with slight taper to 1½ in. from point to flat, except for hydrants to be installed where existing hydrants have different shape or size of nut, in which case the additional hydrant must have operating nut similar to the old ones for uniformity.

Stuffing-Box and Gland

Stuffing-Box—The stuffing-box and gland must be of bronze or suitable noncorrodible metal or bushed with bronze or suitable noncorrodible metal, when an iron or steel stem is used or when an iron operating stem nut passes through the stuffing-box. When packing nut is used, it must be made of bronze or suitable noncorrodible metal. The bottom of the box and end of the gland or packing nut must be slightly beveled.

Gland Bolts—Gland bolts or studs must be at least ½ in. in diameter.

Material—Gland bolts or studs may be either of bronze or suitable noncorrodible metal, iron or steel. The nuts must always be of bronze or suitable noncorrodible metal.

Hydrant Top

Top—The hydrant top must be designed so as to make the hydrant as weatherproof as possible and thus overcome the danger from water getting in and freezing around the stem. Provisions must be made for oiling, both for lubrication and to prevent corrosion. A reasonably tight fit should be made around stems.

There must be cast on top of the hydrant, in characters raised ⅛ in., an arrow at least 2½ in. long and the word "Open" in letters ½ in. high and ⅛ in. in relief, indicating direction to turn to open the hydrant.

Hose Caps

Caps—Hose caps must be provided for all outlets, and must be securely chained to the barrel with a chain constructed of material not less than ⅛ in. in diameter.

Cap Nut—The hose cap nut must be of the same size and shape as the top or operating nut.

Washer in Cap—When requested by the purchaser a leather, rubber or lead washer must be provided in the hose cap, set in a groove to prevent its falling out when the cap is removed.

Markings

Marking—The hydrant must be marked with the name or particular mark of the manufacturer.

Testing

Testing—Hydrants for pressure of 150 lb. or less, after being assembled, shall be tested by hydraulic pressure to 300 lb. per sq.in. before leaving the factory. If the working pressure is over 150 lb. per sq.in. the hydrants must be tested to twice the working pressure. The test must be made with valve open in order to test the whole barrel for porosity and strength of hydrant body. A second test must be made with valve shut, in order to test the strength and tightness of the valve.

Directions to Open

Opening—Hydrants must open to the left (counter clockwise) except those to be installed where existing hydrants open to the right, in which case the additional hydrants must turn the same as the old ones for the sake of uniformity.

[Your committee has not included specifications for hydrants with independent cutoffs, not deeming these hydrants "standard."

Your committee recommends the use of the smaller standard sizes of hydrants at frequent intervals, rather than large hydrants with numerous outlets spaced at longer intervals.]

Specifications for Valves

Castings

Castings—All iron castings shall be made from a superior quality of iron, remelted in cupola or air furnace, tough and of even grain, and shall possess a tensile strength of 22,000 lb. per sq.in. The castings must be clean and perfect, without blow or sand holes or defects of any kind. No plugging or stopping of holes will be allowed.

Test Bars

Test Bars—Specimen bars of the metal used, each being 26 in. long by 2 in. wide and 1 in. thick, shall be made without charge as often as the engineer may direct, and in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars when placed flatwise upon supports 24 in. apart, and loaded in the center, shall support a load of 2200 lb. and show a deflection of not less than 0.35 in. before breaking; or if preferred, tensile bars shall be made which will show a breaking point of not less than 22,000 lb. per sq.in. Bars to be cast as nearly as possible to the dimensions without finishing, but corrections may be made by the engineer for variations in width and thickness, and the corrected result must conform to above requirement.

Makers' Name

Name—Each valve shall have the makers' name cast upon it.

Wrought Iron

Wrought Iron—All wrought iron used shall be of the best quality of refined iron, of a tensile strength of at least 45,000 lb. per sq.in.

Composition Metals

Composition—All composition metals to be of the best quality, and, except the stems, to have a tensile strength of not less than 30,000 lb. per sq.in., with 15 per cent. elongation in 8 diameters, and 15 per cent. reduction of area at breaking point.

Face Joints

Face Joints—All joints shall be faced true and smooth, so as to make, with suitable gaskets, a perfectly watertight joint.

Fittings and Interchangeable Parts

Fitting—The fitting of all parts must be such as make perfect joints and all parts of the valves of the same make and the same size shall be interchangeable.

Valves to open as specified by the engineer.

Bolts and Nuts

Bolts and Nuts—All bolts and nuts in valves to be made from the best quality of refined wrought iron or steel, heads, nuts and threads to be standard sizes.

Kind of Valves

Kind—Valves shall be fully mounted with bronze or suitable noncorrodible metal, and be either of the double-disk or made-up gate type with bronze or suitable noncorrodible metal-mounted wedging devices or have wedge-shaped gates with double faces and seats, designed to work equally well with pressure on either side of the gate. The gates (or disks) shall be of cast iron with bronze or suitable noncorrodible metal faces. These faces shall be machined, dovetailed or driven into corresponding machined grooves in gates (or disks) or riveted on with bronze or suitable noncorrodible metal rivets.

The seats for composition rings in body of valve shall be turned and threaded before rings are screwed in.

To Be Watertight

Seat and Gate Rings—Both seat rings and gate (or disks) rings shall have smooth and true faces, and make a perfectly watertight joint.

Valves shall have hub ends suitable for laying with classes B and C American Water Works Association standard pipe. All valves 24 in. in diameter and larger shall be geared.

Bypasses—Where bypasses are required, they shall, unless otherwise specified, be of the following sizes:

Valve, in.	Bypass, in.
16	3
18 and 20	3
24 and 30	4
36 and 42	6
48	8

Weight—Valves without bypass shall be not less than the following weights for the respective sizes:

Diam., in.	Weight, lb.	Diam., in.	Weight, lb.
3	67	18	1,290
4	85	20	1,650
6	180	24 geared	2,750
8	255	30 geared	5,200
10	400	36 geared	8,500
12	500	42 geared	12,000
14	780	48 geared	18,000
16	900		

Valve Stems

Stems—Valve stems shall be made of solid brass or suitable noncorrodible metal, free from defects, and shall have a tensile strength of not less than 45,000 lb. per sq.in.

Threads—Threads on stems to be square, acme or ½ V, and cut in most perfect manner, so as to work true and smooth and in perfect line throughout the lift of the valve.

Size of Stems—Valve stems at the bottom or base of the thread shall not be less than the following sizes in diameter:

Valve, in.	Diam., in.	Valve, in.	Diam., in.
3	44/64	16	1 28/64
4	55/64	18	1 28/64
5	55/64	20	1 48/64
6	1	22	1 48/64
7	1	24	1 62/64
8	1	30	2 12/64
9	1 8/64	36	2 32/64
10	1 8/64	42	2 48/64
12	1 12/64	48	3 32/64
14	1 12/64		

Wrench Nut—The wrench nut on stem shall be 2 in. square with arrow cast on showing direction which valve is to turn to open.

Painting

Painting—All iron work, after being thoroughly cleaned, to be painted throughout with asphaltum varnish, or suitable paint, or dipped in suitable coating material.

Testing

Testing—Valves must be tested for leakage and distortion as follows: On double-disk or made-up gate type, the body of the valve shall be drilled and tapped with a hole for pipe and a removable plug inserted. Through this hole a hydraulic pressure of 300 lb. per sq.in. shall be applied; the wedge-shaped gate type by an hydraulic pressure of 300 lb. per sq.in. applied, first between one end and the gate, second between the opposite end and the gate, and the third in the bonnet with gate open.

New York City's New Garbage Disposal Contract

On July 31, a contract was signed between the City of New York and John J. Hart, of Peekskill, N. Y., a contractor who has done some construction work on the Catskill Aqueduct, for the final disposition of the garbage of the boroughs of Manhattan, the Bronx and Brooklyn, for a period of three years, commencing Jan. 2, 1914, with the right of the City of New York to renew the contract for another period of two years on the same terms and conditions.

The contract with Mr. Hart is a remarkable one in that the contractor agrees to pay the city for garbage delivered to certain points of deposit on the water-front of the three boroughs at the rate of $62,500 for the first year, $87,500 for the second year and $112,500 for the third year, and the same amount for each of the succeeding two years, if the contract is renewed; a total of $487,500 for the five-year period—where under the present arrangement the city is paying the Sanitary Utilization Co. $50,000 per annum to dispose of the garbage of the three boroughs.

The only other bid received was from the Sanitary Utilization Co., which asked $130,000 per annum from the city for the five-year period, a total of $650,000; so if Mr. Hart's contract proves a success the city actually gains $1,137,500 by this new arrangement. The amount of security required by the city for the execution of the contract is $100,000.

The accompanying table gives an estimate of the amount of garbage collected and delivered to the present contractor during the last six-year period. In the

TABLE OF TONS OF GARBAGE FOR THREE BOROUGHS OF NEW YORK CITY

Year	Manhattan	The Bronx	Brooklyn	Total
1907	187,924	21,175	102,360	311,458
1908	195,439	24,359	105,369	325,167
1909	193,438	26,461	108,586	328,485
1910	197,740	30,274	113,725	341,739
1911	172,224	30,446	115,322	317,992
1912	193,049	34,587	118,267	345,903

Note—Cartloads in The Bronx carry 1.5 cu.yd., and weigh approximately 1750 lb. Cartloads in Manhattan and Brooklyn, except during the snow season, carry 2 cu.yd., and weigh approximately 2330 lb.; during the snow season they carry ½ cu.yd. less. The ton weights given above are based on cartload quantities and are not exact.

borough of Manhattan there are seven dumps where the contractor received the garbage during 1912, in the borough of the Bronx one dump, and in the borough of Brooklyn three dumps. Under the terms of the new contract the contractor or must have a plant capable of disposing of 2000 tons of 2000 lb. each of garbage per day.

The contractor was required to make a special deposit of $40,000 in cash on the signing of the contract, $30,000 of which is to be returned to the contractor at the end of one year, and $10,000 is to remain on deposit until the completion of the contract. By the terms of the contract each proposal was to be accompanied by a certified check for 5% of the amount of the bond ($100,000) and by a set of general plans and specifications setting forth the equipment and methods proposed by the contractor for receiving, transporting, conveying, handling, storing and treating the garbage and its by-products.

Methods, apparatus and equipment for the control of nuisances that may arise during the process of treating the garbage were required to be shown and described in sufficient detail to enable the Street Commissioner to judge of their adequacy and sufficiency. It is an essential requirement of the contract that no objectionable odors, noxious gases or putrescible liquids shall escape during or after the process of treatment to such an extent as to cause a public nuisance.

No estimate or bid was considered unless the system or method of disposal proposed for use had been in successful operation in a city of sufficient size to demonstrate its probable success.

The contractor is required to receive the garbage at water-front dumps, the number of which is not to exceed three in the borough of the Bronx, ten in the borough of Manhattan and six in the borough of Brooklyn. All these dumps or delivery points are to be provided by the city except one in the borough of Brooklyn, which the contractor must provide at his own expense, at a location approved by the Street Commissioner. The location of the dumps may be changed at any time by the city.

The contractor is required to pay every cost and expense of transportation and final disposition from the time the garbage is delivered at the dumps, excepting that whenever the Board of Health shall condemn any material the contractor shall receive and finally dispose of such material at a price of $1.50 per cartload of 1½ cu.yd., which amount is to be deducted from the amount the contractor pays the city under the terms of the contract. The conditions of the contract are given more fully in the following specifications:

SPECIFICATIONS

(1) Wherever the term "garbage" is used in this contract, it shall be taken to mean swill and every accumulation of

food waste, of both animal and vegetable matter, liquid or otherwise, that shall be collected by the Department of Street Cleaning or by carts duly authorized to collect the same, and delivered at the dumps and containing not more than 5% by weight of other refuse.

(2) Wherever the words "dump" or "dumps" are used in this contract, they and each of them shall be taken to mean the place, or places, and all parts and appurtenances thereof for receiving the garbage to be disposed of under this contract, and not exceeding 19 in number.

(3) As the Supervisor of the Harbor, under the laws of the United States, has control over all boats and vessels in the harbor of New York, relative to the removal and disposition of city refuse about the said harbor, all requirements of these specifications are made subject to such jurisdiction and control of the Supervisor of the Harbor, and the Contractor is at all times to obtain the necessary permit before any boat or vessel is removed from any dump and is fully to comply with all other rules and regulations of said officer made in compliance with the law.

(4) The Contractor shall provide and use during the transit of the materials from the dumping place to the point of final disposition a proper cover of canvas or other suitable material, so that the garbage shall be thoroughly inclosed in accordance with the provisions of the Sanitary Code.

(5) As the Department of Docks and Ferries has the exclusive control over all docks, slips, piers and structures erected thereon, except as otherwise provided by law, the Contractor is not to use the slips adjacent to any dump for the purpose of conducting any business or removing any garbage or material other than the garbage required to be removed by the terms of this contract, unless permission in writing therefor is first had and obtained from the said Department of Docks and Ferries.

(6) No money, reward, gratuity, fee or other valuable consideration shall be charged, received or taken by the Contractor or any of his agents or employees for doing or failing to do any part of the work required to be done under this agreement, excepting as provided for in the removal of material condemned by the Board of Health.

(7) All the garbage is to be disposed of in a manner not prejudicial to the public health, and the process employed by the Contractor is to be not only not noisome in its operations, but also to be effective as to final results.

(8) The entire work of final disposition is to be at all times accessible to the Commissioner and his authorized representatives and under his supervision and inspection, and subject to his approval.

(9) The Contractor is at all times during the day and night to have at all dumps such a number of transporting conveyances as may be necessary for the proper reception and transportation of all garbage delivered at said dumps. Garbage will be collected and delivered at the dumps either during the day or night, as the Commissioner may direct.

(10) The Commissioner is to have the right at any time to change the location of any City dump or dumps in the Boroughs of Manhattan, The Bronx and Brooklyn, if in his judgment the interests of the City shall so require, and without previous notice to the Contractor; but as soon as possible after such change of location has been decided upon, the Commissioner is to notify the Contractor thereof.

(11) No place other than the dumps provided for in this contract is to be used by the Contractor for the receiving or handling of garbage except by special written permission of the Commissioner previously obtained.

(12) All receptacles, scows or conveyances of whatsoever kind used by the Contractor are to be so constructed and loaded as to prevent the garbage or any part thereof from falling into or defiling the water of New York Harbor or the waters adjacent thereto, and the said receptacles, scows or conveyances and each of them is to be kept and maintained in a clean and sanitary condition to the satisfaction of the Commissioner.

(13) The garbage received at the several dumps is to be removed therefrom at least once in every 24 hours, unless the Commissioner shall for special reasons extend in writing the time for such removal.

(14) All labor necessary for the loading and trimming of the receptacles, scows or other conveyances employed by the Contractor is to be furnished by the said Contractor.

(15) The Commissioner is to repair all damage done by the Contractor to the city dumps, for account of and at the cost and expense of the Contractor.

(16) The Contractor shall provide and maintain at his own expense an office in connection with the work of this contract conveniently located and will provide at his own cost and expense telephone service at all hours of the day and night at said office.

(17) Any person in the employ of the Contractor who, in the opinion of the Commissioner, may be untrustworthy, incompetent, or otherwise unfitted to perform his duties, or who shall refuse to obey the orders of the Commissioner or his duly authorized representative, is to be dismissed on the request of the Commissioner, and any person so dismissed is not again to be employed by the Contractor without the Commissioner's written consent.

(18) The Contractor will provide, keep in operation and working order a plant of the capacity ample to dispose of at least 2000 tons of 2000 lb. each of garbage in each 24 hours, and have the same complete by the time that work is to begin under this contract, except that he or they may with the approval of the Commissioner provide satisfactory means of temporary disposal of the garbage for an initial period not to exceed four months, at the expiration of which time the plant shall be capable of handling all the garbage at that time being delivered to the contractor under the terms of this contract.

It is stated by officers of the Street Cleaning Department that the contractor proposes to erect a thoroughly up-to-date reduction plant, similar in all important details to that in successful operation by the City of Columbus, Ohio, a complete description of which may be found in ENGINEERING NEWS of Nov. 17, 1910. The capacity of the Columbus plant is 160 tons per 24 hours, or more than $\frac{1}{12}$ of the capacity of the plant required for treating the New York City garbage.

The contractor proposes to erect the reduction plant on Rubble Bar, a sandy island in Jamaica Bay, but nearer to the shores of the residence sections of the boroughs of Brooklyn and Queens than the present Barren Island plant of the Sanitary Utilization Co. To this location the property owners of that locality have objected—as is usual in all such cases. By a late amendment to the contract, the definite location of the plant was left to a special committee of the Board of Estimate and Apportionment. The contractor has about nine months in which to have the plant ready for service.

NOTES FROM THE ENGINEERING SCHOOLS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—A new course of instruction is to be inaugurated at the Institute; aërodynamics, the foundation of all work with the aëroplane. At the request of President Maclaurin, Secretary Daniels of the Department of the Navy, has detailed Assistant Naval Constructor Jerome C. Hunsaker to develop the course. Mr. Hunsaker will first be sent to Europe, where he may have authoritative access to the great aëronautic laboratories.

A department of electrical-engineering research has been organized at this school and placed under the direction of Prof. H. F. Pender. An anonymous donor has given $25,000 for the analysis of electric-railway operating expenses; $10,000 a year for five years has been given by the American Telephone & Telegraph Co., which has also given the Dering library of over 30,000 books, under this grant the study of conditions affecting the clearness of speech in telephone communication will be taken up. Some $2000 has been received from the Boston & Maine and the New York, New Haven & Hartford R.R.s, to be used for the study of freight handling at terminals. Some time ago $7500 was given by the Edison Electric Illuminating Co., of Boston, for the study of utilization of electric-motor vehicles in cities. The total gifts and promises are stated to amount to over $200,000.

Remarkable Speed in Masonry Construction was attained in the past month on the foundations of the great Kensico Dam, on the New York water supply, for which H. S. Kerbaugh (Incorporated) has the contract, with Beverly R. Value as Chief Engineer. According to information furnished by Mr. Value, from June 25 to July 24, inclusive, which is the monthly interval comprising estimate No. 39, Contract No. 9, Board of Water Supply, 42,300 cu.yd. of masonry was placed in the foundation of the Kensico Dam. This masonry was classified as follows:

Cyclopean masonry	38,640 cu.yd.
Mass concrete	1,990 cu.yd.
Concrete blocks set	1,670 cu.yd.
Total	42,300 cu.yd.

This amount of masonry was laid in 25 working days of eight hours each, the work being performed by six gangs of masons. In addition to the above, 4350 cu.yd. of concrete blocks were cast in the block-yard on the work.

It is believed that the work represents a record rate of progress on masonry construction, exceeding all but the highest records attained on the largest works where concrete alone is placed.

EDITORIALS

11,000-Volt Electric Traction for the Norfolk and Western Ry.

The announcement, elsewhere in this issue, that the proposed substitution of electric traction for steam on a mountain section of the Norfolk & Western Ry. would employ an 11,000-volt single-phase system with induction motors on the locomotives, has many features of unusual interest. Doubtless, the result is contrary to the expectation of many, since the advisability of using this particular system was fixed by engineers whose most important previous work is seen on the direct-current third-rail system of the Pennsylvania R.R.'s New York terminal. The news will perhaps come as a surprise to those who have been turning toward the use of direct currents at 2400 volts or higher to meet those trunk-line conditions which in the past have pointed to the use of high-tension alternating current in contrast with low-tension (600 volts) direct current. Further details of the Norfolk & Western plans will be awaited with interest, particularly the design of the single-phase induction motor which in its simple form has very low starting torque. Some light also will be generally looked for, we are sure, on the conditions which led to the selection of this type of motor in preference to the highly developed series commutator type of single-phase motor and which ruled out the three-phase traction system in successful use in this country on the Cascade tunnel line of the Great Northern Ry.

If this announcement signifies any one single thing particularly, it is that the "battle of the systems" is over and that American electric-railroad engineers have arrived at the point where they can be relied on coldly and dispassionately, without regard of previous tendencies, to weigh the peculiar merits of any system as affected by any local conditions involved in a particular case.

Once More the Longest Concrete Arch

In reinforced-concrete arches, as in transatlantic steamers, the palm of superlative greatness is transitory. Hardly are the centering timbers down, in the one case, or the maiden voyage over in the other, before the blueprints of a greater bridge or boat are hanging to dry in the office of some ambitious engineer. Structural progress is not solely a matter of greater dimensions, but is more easily measured that way than in any other.

For two years the 328-ft. Risorgimento arch across the Tiber at Rome has been the longest reinforced-concrete span in the world, taking the title from the 320-ft. Grafton arch at Auckland, N. Z., completed about a year earlier. A paragraph on another page of this issue notes the present construction in the eastern part of Switzerland of the latest "largest masonry arch" in the 330-ft. span at Langwiez, on the meter-gage railway between Chur and Arosa. Full particulars of the design of the bridge are not at hand, but it is noted that the new bridge is a much more massive structure than its nearest rival. The Tiber arch has a rise only one-tenth its span and is of a most astounding slenderness; the span of the new Swiss bridge rises about one-half of its length and has structural dimensions more nearly compatible with its great size.

The succession of these large concrete arches is an indication of the essential conservatism of the engineer. Not by leaps and bounds have their spans increased, but gradually, slowly, by feet and inches, the record arch has passed its predecessor. Read the records of the "largest arch in the world" for the past few years—Walnut Lane, Philadelphia, 233 ft., 1907; Sitter, Switzerland, 259 ft., 1908; Rocky River, Cleveland, Ohio, 280 ft., 1910; Monroe St., Spokane, Wash., 281 ft., 1911; Grafton, Auckland, N. Z., 320 ft., 1910; Risorgimento, Rome, 328 ft., 1911; Langwiez, Switzerland, 330 ft., 1913. An orderly progress, disturbed only by the remote possibility of the consummation of the 703-ft. span across Spuyten Duyvil Creek in New York.

The New York Garbage-Disposal Contract

The folly of short-term garbage-reduction contracts was commented on in our issue of July 3. We stated that it is questionable whether even a ten-year contract is sufficiently long—having in mind the possible recovering of capital from profits within a few years unless the city pays a high price for disposal.

The question is raised again by the remarkable contract let by the City of New York on July 31, as noted elsewhere in this issue. Under this contract the city, instead of paying for garbage disposal, will sell its garbage to the contractor at various city dumping piers on the waterfront. From these dumps the contractor must transport the garbage by boat a considerable distance and then dispose of it without nuisance in a garbage-reduction plant. This plant must have a capacity of 2000 tons a day. *The contract is for only three years,* but the city may extend it for two years longer if it sees fit.

Assuming that the city does not extend the contract, then to come out even the contractor must make enough money in three years to (1) cover the cost of his plant plus interest and minus salvage; (2) operating expenses for both transportation and reduction; and (3) the price paid to the city for the garbage. We do not presume to say that the contractor cannot do this and come out even. We only wish to call attention to the apparently speculative character of the contract; speculative, first, as to the chance of the possible two-year extension and, second, as to the hope of again getting the contract at the end of five years or else selling the plant. Possibly still another element of speculation entered into this bid; that of being able to buy the plant of the present contractor at a price much less than the cost of installing a new plant.

The great difference between the bids of the holders of the present and the new contract appears to be strong evidence of the folly of short-term garbage-reduction contracts. The present contractor, after years of experience and with a plant in running order, demanded $130,000 a year for the same work; the new contractor, without previous experience in this particular line, agrees to pay the city an average of $95,833 per year for three years.

On the face of it, one or the other of these contractors bid wild. Actually, it looks as though the old contractor banked on the strength of his intrenched position as holder of the New York garbage-disposal contract for many years against any new comer without an established plant, while the new contractor banked on holding the contract likewise if he could once get it. This seems more like gambling than competitive bidding.

Real competition in any work involving such extensive capital outlay as garbage reduction cannot be expected under a three-year or even a five-year contract unless there is far more profit in garbage grease and tankage than contractors have admitted heretofore or than appears to be shown by the Cleveland and Columbus municipal garbage-reduction plants. We sincerely hope that the New York contract authorized on July 31 will demonstrate that hereafter the garbage of our cities may be a source of revenue instead of a heavy expense.

Utilizing Low-Grade Temperature Drops as a Source of Power

Elsewhere in this issue, a contributor offers an interesting suggestion as to the possibilities for obtaining power for commercial purposes by utilizing the warm surface water of tropical seas. He explains the plan by which the cold water from the ocean depths could be brought to the surface for condensing purposes, and estimates that in this way a permanent temperature drop of some 40 deg. F. could be obtained. His thermodynamic computations appear to be close enough for the rough estimate which he makes; and his speculation is an interesting one, since it draws renewed attention to the possibility, whenever and wherever power becomes valuable enough, of utilizing temperature differences found in nature for the commercial production of power.

As some of our older readers will recall, this matter has been brought forward in these columns before. In the explanation of the Series Engine on which the late A. M. Wellington did much work in the last years of his life, it was pointed out that the ultimate value of such inventions lay in the possibility of utilizing for power production the low-grade temperature drops which have thus far been neglected.

In the past score of years, a great deal of work has been done in utilizing low temperature drops. The development of the steam turbine, and especially of the exhaust-steam turbine, with the greater perfection of the condenser and the air pump, have made possible the use of power production, with water as the working fluid, of a temperature drop of only some 150° between the exhaust steam and the condensing water. In fact the early low-pressure steam engines relied almost wholly for their power upon the condenser; and from that point of view Newcomen and Watt and their contemporaries of a century and more ago were really pioneers in the use of low-temperature drops for power production.

Mention may also be made of the work which has been done in utilizing exhaust steam for the evaporation of volatile fluids for power production, such as the carbonic-acid engine of Professor Josse. It is generally agreed that if the exhaust-steam turbine had not been developed, the carbonic-acid engine would by this time be in extensive commercial use.

Mention may also be made of the interesting work done during the past ten years in the utilization of the sun's heat for power, by Frank Shuman, of Tacony, Philadelphia, records of which have appeared in ENGINEERING NEWS at various times. The widely extended use of artificial refrigerating machinery has familiarized the engineering world with the use of working fluids which are gases at ordinary temperature, and has thus paved the way for the ultimate development of commercial engines using volatile vapors to utilize low-grade temperature drops.

With reference to our contributor's proposition to utilize the heat of tropical seas for power, it is correctly pointed out by him that one of the chief commercial difficulties in the way of his proposition is the lack of a market in such localities for the developed power. Many promoters and investors in water-power plants in remote locations are only too well aware that it is not sufficient to develop a large supply of power at a very low cost. If dividends are to be earned, a market must be found for the power at a price which will yield a profit.

We may supplement our correspondent's suggestion by pointing out that there exists a possible source of power which is available anywhere and which can be utilized whenever the art of developing power from a low temperature drop is sufficiently developed. We refer to the heat of the earth's interior. It is already practicable to sink boreholes and mine shafts to a depth of two miles, or more. By circulating water down such shafts and back to the surface, the heat of the deep strata can be brought to the surface. It may be said that by the constant circulation of cool water down the shaft and back the deep strata would eventually have their temperature reduced so that the deposit of heat would eventually be "worked out" like a coal mine.

The enormous bulk and weight of the deep lying strata, however, which would slowly conduct their heat to the flowing stream, would probably make the life of such a source of heat very long.

Of course the deep underground temperatures vary greatly in different parts of the earth according to geological conditions, very high temperatures being found at moderate depth in rocks where volcanic action has taken place within recent geologic time, while in the oldest rocks much greater depth would probably be necessary to attain high temperature. When one considers the enormous volumes of hot water discharged from the mines on the Comstock Lode, or from the long Alpine tunnels, such as the Simplon, one is encouraged to believe that a great amount of power could be obtained from this stored heat in the underground strata, and at an expense which need not be prohibitive.

It is interesting to draw a parallel between the development of the natural resources of the earth in minerals and in power. As is well known, in the development of the mineral industry, it has been the rich, high-grade deposits which first attracted attention and have first been commercially worked. It was not until the best of

these were exhausted and the product became increasingly valuable, that means were found to work the vastly larger deposits of low-grade ores which were formerly considered wholly worthless. So in the art of power development. Man has hitherto only made use for power development by heat engines of the high-grade drops in temperature produced by the combustion of coal, oils and other fuels. The increase in knowledge may make it posible to turn to the low-grade temperature drops which occur in Nature, as an ultimate source of power.

Some Random Suggestions to the Engineering School Graduates of 1913

The cap and gown of the college commencement exercises have been put aside; the echoes of stirring appeals to the graduating class have died away; the young men whose debut into their life work was made with such eclat have come down to the prosaic problem of earning a living, and are wondering perhaps—at least the ambitious ones—just how they may shape their lives to win the measure of success which, to the young beginner, seems so far away and uncertain of attainment.

We shall not pretend within the brief limits of space here available, to give a complete recipe for attaining eminence in the profession, or even such a limited measure of excellence in life and work as each man's inherent abilities may make possible. It may be useful to some young and ambitious graduates, however, to suggest a few things that may aid them to make the most of themselves and their opportunities.

And the first suggestion we would make is the necessity of keeping abreast of professional progress. The young engineer is too apt during the first year or two after graduation to slough off such studious habits as he may have acquired during his student years. He will probably concentrate entirely on the particular line of engineering work on which he is engaged and pay little attention to anything else. But many of the most successful engineers have earned their success in good part by their ability simultaneously to keep in general touch with engineering progress and at the same time to stand at the head in their own especial field.

A few months ago the chief engineer of a well known manufacturing company was made the engineering director of one of the greatest engineering, contracting and financial concerns in the world. He had perhaps been widest known as a designer, and those who did not know him well were surprised at the apparent difference of his past and his prospective work. A close scrutiny of his career disclosed, however, his grasp of general engineering, of economics, and of commercial and financial affairs; and explained, for instance, why although the head of the designing staff, he was considered the best salesman the manufacturing company possessed and was employed in securing its largest contracts.

The young engineer asks how he can develop such capabilities. Of course, it must be understood that few have the inherent ability to win such a measure of success in such widely different fields of work; but perseverance and industry and dogged determination are often as large elements in winning success as the possession of brilliant genius, especially if the genius is not held down to regular work by a reliable balance wheel.

We shall be repeating, doubtless, what the young graduate has heard many times from his instructors, when we say that his study of his profession at graduation has just begun. If he rightly uses his time and strength, he will learn more engineering during the year to come than he has learned in any year in college. His textbooks henceforth, however, he may choose from the whole field of engineering literature.

Without attempting to specify in detail as to what should be chosen in engineering literature, we would urge first that the habit be early formed of regularly reading some technical journal devoted to the special branch of engineering in which the young graduate is engaged and in addition some other which covers a broad field of engineering development.

The young engineer will do well to subscribe for the papers he selects to read, if he can afford them, but he should read them in libraries if he cannot make ends meet otherwise.

The mistake which the young engineer often makes is trying to read too much. When we say read a technical journal, we do not by any means advise reading it from cover to cover. Right at the start the young engineer should begin to cultivate his critical faculty, and select only the articles that are best worth reading, either because of their bearing on his own work, or because they are part of engineering progress worth knowing about.

A plan followed by many is to size up an issue of a journal at the start, locating the articles which appeal as of most importance. The articles are then read as opportunity offers and in the order of their importance.

The complaint not infrequently reaches us that not enough is published in ENGINEERING NEWS on this or that or the other specialty. Not seldom in the same mail we receive a complaint from some other subscriber that too much space is given to the very subject which the first man complained of as deficient, and not enough to the special field in which the second man is interested.

The evident difficulty in both these cases is that each of these men is confining his reading entirely to his own limited branch; they are making themselves specialists, not engineers. Some day, when one of the revolutionary changes in engineering work comes of which the past quarter century has seen so many, they may find their specialty displaced and, like Othello, their occupation gone.

We would emphasize, therefore, that the young engineer needs to keep himself posted, not only in his own special field, but in the lines of work related thereto. The youth engaged in signal engineering, for example, should lose no opportunity to learn all he can about other departments of railway work, the problems of the maintenance-of-way engineer and the motive power department, as well as the problems of the operating force with which his work is so closely in touch. Matter on paints and concrete, compressed air and electrical machinery all have a close relation to his own tasks.

But the young engineer should not confine his reading and study to engineering, even in its broader aspects. Every large engineering problem and most of the small ones have an economic side. The engineer of today is asked in nine cases out of ten not "Can it be

done?"—but "Will it pay?" In fact, his job may depend on being able to show how it can be so done as to yield an attractive profit.

Engineering students too often shun the study of economics. After graduation, they find the need of such knowledge. We need only refer to the great work of valuation on which thousands of engineers are now engaged, to indicate the importance to an engineer who aspires to a high position of mastering the fundamentals of economics as taught by the best thinkers of the present day.

Another idea which has pervaded all fields of engineering effort within the past few years is the recognition of the need of maximum economy and efficiency in industry. We have heard much in the past about the dignity of labor; we will hear more in the future about the dignity of economy and the sins of extravagance. Nothing helps more to secure a proper point of view than habitual economy in personal expenditures, and habitual effort to secure efficiency in one's own work.

Moreover, there are simple aids to increasing personal efficiency which are now generally recognized by physicians and psychologists. Space prevents more than the merest mention of a few important points involved: rest should be in proportion to the amount and character of fatigue; concentration of thought, vision, touch or any special sense should be followed by relaxation; memory should be aided by suggestive memoranda; strict personal hygiene is to be observed; tasks are to be split up into small units and completed step by step; confidence in one's ability to do certain work should be maintained; while forethought is to be cultivated, yet worry must be driven out by persistent optimism as to results. In this connection the young engineer's list of books "to-be-read" could profitably include such works as Dr. Luther Gulick's "Mind and Work" and "Efficient Life."

The young engineer will do well to keep himself in touch and sympathy with that great current setting toward increasing regard for human rights and better conditions of living and working; but he should watch himself meanwhile that he be not swept off his feet by the fallacies and extravagances which accompany many of these new movements. The possession of broad human sympathies and a liberal mind is quite compatible with the maintenance of a sane and cool judgment. It is as much the task of the young engineer to critically sift the claims of Socialism or the Safety movement or the Commission form of municipal government as it is to critically sift the arguments for and against electrification of steam railways or the meter system for waterworks.

Broad knowledge of engineering and of the best current thought of today and a thorough grasp of one's own field of daily work constitute two factors in a successful career. But this success is like volume; it has a third dimension and is a maximum when the three are equal.

The third factor is the man's "dynamic component"—his combination of push, persistence, will power, feelings, sympathies, tastes and other qualities of character.

It has been freely admitted that the breadth and depth factors were considerably under the control of each individual, but it has been assumed that control of the dynamic component was beyond conscious control and that so far as character went we were children of destiny. But the doctors and phychologists here again have shown our mistake.

The lazy man can work hard and effectively on his own initiative, the "fuzzy-minded" can think clearly, reason logically and act consistently, the stingy can become charitable, the gloomy become bright; an average mental equipment under conscious control can give larger intellectual achievement than a great mind unharnessed. A well known engineer was asked how a young man could cultivate this dynamic component. His reply was "Take responsibility; don't refer everything to your boss; relieve him of his load; put your shoulder under more than he loads onto you."

Such a postgraduate program as is above sketchily indicated cannot, of course, be followed with perfect consistency. Temporary lapses must be expected, but a fresh start can be made as often, and ground once covered is never quite lost. Occasionally it is well quietly to turn inward for a candid scrutiny to see where mental and physical life is not hygienic, where rest and relaxation are not kept proportional to work, where all the ready aids to efficiency and effectiveness are not employed, where tasks might be set that sweep one along against natural disinclinations, where added responsibility may be wisely directed, and wherein knowledge of a selected field lags behind real progress. A concise formal statement of such a program can be drawn up—a sort of map of the mental fortifications; and it easily leads to spotting the breaches which require mending. In such ways is a lasting interest in work maintained and that bugaboo of professional life, time's assault on mental strength, effectually repulsed.

LETTERS TO THE EDITOR

The Lackawanna's Chief Engineer on the Autoclave Test

Sir—I have carefully read your editorial on the "Recent Developments in the Autoclave Test for Cement" in your issue of July 10, 1913, p. 82.

This editorial calls for a response from me, and I am glad to take this occasion to advise you and engineers in general that we shall be very glad, indeed, to give out, for the benefit of all concerned, such information as we now have, as well as such data as we may hereafter secure in connection with developments of the autoclave test.

If I am correctly informed, the published extracts of the discussion on this subject at Atlantic City, as well as your editorial, do not give the reader an adequate idea of the apparent opposition to this new test. There can

be no question but what there was an unusually strong undercurrent at Atlantic City fed by an apparent bitterness and opposition, the continuation of which is not apt to assist in the solution of this problem.

The data given in Mr. Force's paper were given to the society as information and for the express purpose of inviting discussion by those interested in the subject, and especially by those who have made an investigation of the merits of the autoclave tests. Altogether, these discussions have brought out much interesting information. Dr. Cushman's report, as well as the discussions by Mr. Ferguson and Dr. Spackman, may be taken by some as convincing argument that the autoclave test is erratic and unreliable. In fact, the two discussions noted treat the subject with a view to show that the results of Mr. Force's tests indicate that the cement passing the autoclave test is in reality a poorer cement than one which does not pass the test. I stand firmly on the ground that they have in no way proved the autoclave test to be worthless, nor have the investigators given any sound reason for various brands of cement, or in fact different shipments from the same mill, behaving so differently under this test. Mr. Wig's compressive test shown in his paper, so far as these tests have been carried, indicates that a cement which passes the autoclave test shows the greatest strength, while the cement which will not pass the ordinary boiling test shows the least strength. I have noted that a great many of the cement companies' experts pretend to be doubtful about the value of the standard atmospheric steam test. Therefore, one would not expect them to readily fall in line with a high-pressure steam test.

Dr. Cushman contends that, in all probability, the autoclave merely produces "in addition to ordinary hydraulic bond a silica-lime bond which can only be produced under the action of high-pressure steam." Assuming that Dr. Cushman is right, why is it that this silica-lime bond is always produced with the cement from some mills and only produced part of the time with cement from other mills, while with some samples even the hydraulic bond is entirely destroyed under this test? Why this difference, and all with cement which passes the standard specifications in every way, and shows no abnormal signs, even under careful chemical analysis? I am frank to say that I have no explanation for this peculiar action, nor do I pretend to know what is necessary in the manufacture of cement to secure a product which will pass the autoclave test. I do know, however, that so long as the cement people are unable to show why their product produces such varying results under this test, I shall insist on using in important work only such cements as will pass it, at least until time proves that it is a useless test.

A year ago last spring, when we were considering the adoption of the autoclave test for all cement to be used on our new and important work west of Scranton, Penn., I had various conferences with the cement people. At that time some of the companies took the stand that they knew nothing about the test and believed it would eliminate some perfectly good cement. They did not know what to do to make their cement pass the test and, therefore, did not want to undertake to meet the same. All, with one exception, expressed a belief that any cement which passed the test in addition to the standard test would surely be a good cement. The one exception claimed that any cement passing the autoclave test would be a dangerous cement to use. I am inclined to believe that this party later changed his mind, especially when he found that about half of the product from his mill would pass the test, while the other half would not.

The autoclave test was adopted by the Lackawanna railroad at the time we closed the contract for the construction of the Tunkhannock Viaduct. The successful completion of this gigantic structure is up to me and should mean considerable to the cement companies. In round numbers it will be 2400 ft. long, have a maximum height of 246 ft., and will contain about 165,000 cu.yd. of concrete. The construction of this bridge of concrete would not have been considered at all had I not unlimited faith in good cement. To conclude it advisable to construct the bridge of concrete as compared with steel it was necessary to assume that the completed structure would stand for many years without the necessity of repairs.

The cost of the cement for the Tunkhannock Viaduct will only be approximately 8% of the entire cost of the structure, so that the percentage of the increased cost of the completed structure on account of using autoclave cement must necessarily be very small.

Time may show that our trouble and expense have been unnecessary, and even if the strength-time curves produced in your editorial and those given in the discussion by Mr. Ferguson from the data in Mr. Force's paper should hold true with extensive tests over a longer period, the autoclave test might still prove to be of great value since by it we could quickly determine cement which will show any unreasonable reduction in strength after a lapse of three months.

G. J. Ray,
Chief Engineer.
Delaware, Lackawanna & Western R.R.
Hoboken, N. J., July 28, 1913.

[Mr. Ray's very frank letter is ample evidence that he is of a fair mind toward an impartial investigation of the autoclave test. Very obviously such an investigation must be in the hands of independent men and should not be at all influenced by those commercial interests who might be affected by a decision in favor of the test. Such an investigation is now absolutely incumbent upon the cement committees responsible for our standard tests.

That there is much half-baked knowledge of the subject is evidenced by a recently received post-card advertisement of a "chemical engineer" engaged in the commercial testing business. The advertisement, apparently widely circulated, says among other things,

We are equipped to make the "Force Autoclave Test." By this test we can tell in 28 hours after receiving the sample just what to expect of the cement. NO NEED TO WAIT for 7 and 28 day tests. SAVE DELAY and the EXPENSE OF STORAGE of cement.

The test is being adopted by the leading Eastern chemists.

—Editor.]

Some Facts Concerning the Corrosion of the Port Elizabeth, South Africa, Steel-Pipe Line

Sir—In reference to the Port Elizabeth steel-pipe line noted in your issue of Apr. 3, 1913, I find on inquiry that the outside coating (Angus Smith) had, owing to carelessness in transportation, been considerably dam-

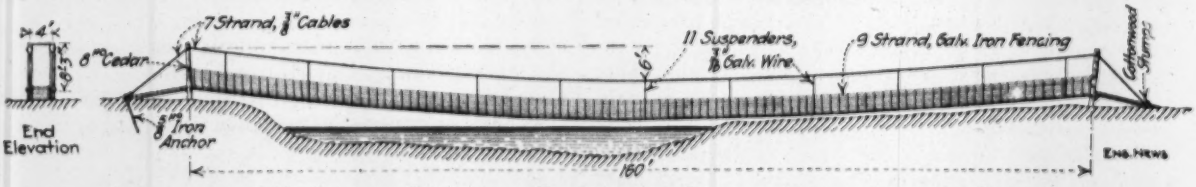
aged, leaving the steel exposed. The pipes were laid in the ground just as they were, without recoating. The inside coating was good, and the water passing through had no corrosive effect; it was from the outside that deterioration commenced and has worked so disastrously that it has been decided to lay a new cast-iron main some miles in length. The cost of this new work is estimated at about £200,000. The old steel main has been in place for only a few years, and, had it been recoated before laying, would have been in good condition at the present time, and would have cost £119,000 less than cast-iron, owing to lighter freight charges.

SUBSCRIBER.

Cape Town, South Africa.
June 30, 1913.

A Remarkable Suspension Bridge

Sir—I am inclosing a description of a suspension bridge for pedestrians, which, needless to say, was designed and erected without the services of an engineer. This bridge crosses Pincher Creek in the town of Pincher, Alta., and was erected in 1911 by a member of the town council at a cost of $90, some $25 of which was contributed by the town. Fortunately, it crosses a shallow stream and not a cañon. The span is 160 ft.



A REMARKABLE SUSPENSION BRIDGE FOR PEDESTRIANS, PINCHER CREEK, ALBERTA, CANADA

The posts carrying the cables are about the size of ordinary telephone poles, some 8 in. in diameter, and are planted a few feet in the ground with a backward inclination away from the span. The anchorage at one end is a cottonwood stump and at the other end ⅝-in. round iron rods driven into the ground.

The foot-walk is made of three 1x10-in. boards laid horizontally on 1x8-in. boards spaced about 3 ft. c. to c., which are carried on 5 strands of woven-wire fencing laid horizontally for a floor system. The woven-wire fencing is suspended on each side by 11 uprights of $\frac{3}{16}$-in. galvanized-iron wire attached to each cable. The cables themselves are 7-strands of ⅛-in. wire. The cable saddles are ¾-in. iron pipe passed through auger holes in the posts. The cables and the floor hang in the same catenary, as the suspenders are all of the same length.

The hand railing on each side of the walk is of 9-strand woven-wire fencing, which is wrapped around and fastened to the end posts, and obviously carries no small share of the load. Both the hand-rail fencing and the floor-system fencing are highly stressed and to resist their pull on the end posts short-cable anchorages have been added since the erection. The walk hangs only about 3 ft. above the surface of the water.

The most remarkable thing about this bridge is probably the small size and wide spacing of the suspenders, one of which had already broken when the writer visited the structure, but this did not, however, prevent his effecting a passage in safety. The bridge is a convenient means of visiting a hospital on the north bank of the stream and is used by many women and children.

D. J. MCLACHLAN.

Calgary, Alta., June 9, 1913.

NOTES AND QUERIES

It has been brought to our attention that Table I of H. M. Gibb's article on retaining wall design published in our issue of July 24, 1913, p. 171, appeared in practically the same form in the first edition of Prof Malverd A. Howe's "Retaining Walls for Earth."

Ernest McCullough, Consulting Engineer, of Chicago, Ill., referring to a letter in our columns on July 24 on "Retempered Mortar as a Bond between New and Old Concrete," calls the attention to an article on the subject of retempered mortar in "Engineering News," Jan. 11, 1906. Mr. McCullough states that he has used retempered mortar for 25 years and has never been able to understand why it is so universally forbidden in specifications.

In the article in our issue of July 17, p. 116, on the proposed double-deck bascule bridge over the Chicago River, at Michigan Ave., Chicago, Ill., the design of the structure was credited to C. D. Hill, Chief Engineer of the Board of Local Improvements. Mr. Hill informs us that while he had charge of the improvement as a whole, including all approaches, pavements, electric lighting, etc., the plans for the bridge proper were prepared in the Bridge Department of the City of Chicago by Alexander von Babo under the direction of A. J. Hammond, Bridge Engineer.

The Oldfield Patent Bill—Pending in Congress today is a bill which cuts down from seventeen years to three years the most essential protection now afforded to manufacturing patent owners. Reported favorably by the House Committee on Patents in the last Congress, and reintroduced in the present Congress by Chairman Oldfield of that Committee, its possibilities of evil to small manufacturers, to independent inventors, and to their industrial research, experimentation and development, that alone keep America in the front rank of nations, constitute the most menacing cloud upon the business horizon.

The Oldfield bill proposes that if any applicant shall establish in a Federal district court that a patent owner, who has purchased a patented invention from the original inventor, is withholding it "with the result of preventing any other person from using the patented process" more than three years after the patent is issued, the court shall order the patent owner to grant to the applicant a license to use the invention upon such terms of royalty as the court "deems just." The burden of litigation which this proposal involves would give large corporations the greatest advantage over ordinary patent owners.

The excuse offered for this universal proscription of patents is that patents are sometimes "suppressed." For 27 days the House Committee on Patents took testimony upon the Oldfield bill, and not a single case of "suppression" was cited. Almost unanimously the witnesses emphatically opposed the bill with conclusive proofs that its proposals were unwise.

If the small, independent manufacturer could be compelled to license his big competitors to manufacture all the second and third best inventions that he has acquired, tested and laid aside in favor of his best invention, his big competitors, with their superior advantages of capital and selling organization, could soon crowd the smaller manufacturer, even with his superior invention, completely off the market. Instead of preventing "suppression" of inventions, the Oldfield bill would really facilitate it.—From an address by Gilbert H. Montague at the Detroit Meeting of the National Association of Manufacturers.

Hoisting Heavy Girders 250-Ft. Above the Street

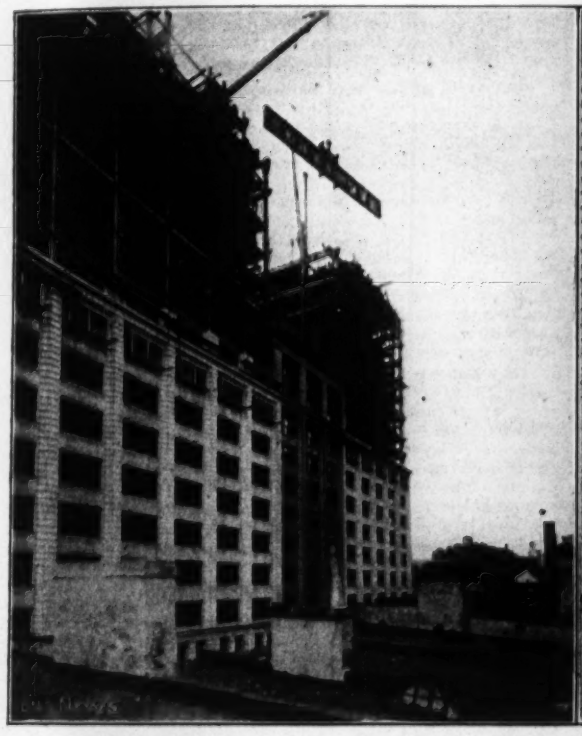
The desire of the Consolidated Gas Co. to add seven stories to its present 12-story building at 15th St. and Irving Place, New York City, thus making it of the same height as the new building of this company, now in the course of erection on each side of the old structure on 15th St., has led to an unusual feature in building construction. As the old building is not strong enough to bear this additional weight, it was decided to suspend six of the seven additional stories from heavy girders in the roof of the addition, the girders themselves being supported on steel columns 250 ft. high, reaching to the ground, alongside the old building. The seventh additional story rests on the girders.

the girders required 12 hr., distributed over Aug. 1-3; the last girder, weighing 40 tons, being lifted and placed in 12 min.

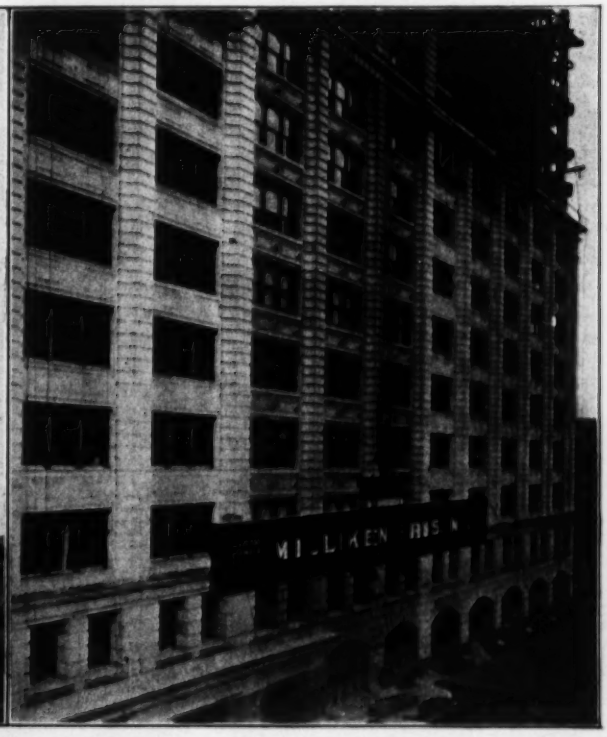
An especially designed balance beam with two sets of clamps for attaching the derrick cables to the girder, was used. A 12x12-in. engine furnished power for raising the girders. The hoisting drum contained 4000 ft. of ⅝-in. cable, using six sheave blocks, 13 parts of cable.

The girders are supported on columns placed close to the sides of the existing building. Each column extends vertically a distance of 250 ft. and is constructed in seven lengths. The columns rest on steel and concrete footings, reaching down to bed rock.

The rated capacity of the derrick was about 80 tons at 35-ft. radius, and 50 tons at 60-ft. radius. The weight of the derrick with its load, imposed loads on the building



SETTING THE FIRST GIRDER IN ITS PERMANENT POSITION



LIFTING THE FIRST GIRDER FROM THE STREET TO THE 19TH FLOOR

(In like manner eight girders were lifted. There were two 30-ton, two 35-ton, and four 40-ton. The above photographs are of a 35-ton girder.)

The largest girders are 63 ft. long, 8 ft. deep, and weigh 40 tons each. They are at an elevation of 250 ft. above 15th St. The eight girders, having a total weight of 300 tons, were conveyed to the foot of East 15th St. on one lighter. They were carted singly from there to the job on trucks of special construction, each drawn by 34 horses. The truck wheels were of steel and had 18-in. treads. The girders were unloaded from the trucks and placed upon the street by means of a large steel stiff-leg derrick with a 70-ft. boom, installed on the 19th floor of the new building. The work of handling the eight girders from the dock to the job consumed only one day.

After their delivery at the site, the girders were lifted, one at a time, by this same derrick, and placed in their respective positions. The actual hoisting and placing of

far in excess of its design; hence, it was necessary to design special timber bracing which would distribute the maximum reaction of 140 tons at the base of the derrick, down through several tiers of floor girders. The uplift at the outer ends of the derrick sills was taken by steel beams and 1¼-in. steel cables, the latter carried down five stories, and there attached to the columns at their intersection with the floor girders. In addition, nine adjacent panels of the building structure were diagonally braced in both directions with steel cables, to resist all tendency toward racking the building horizontally. No vibration was detected when the girders were set in place.

Bridging across the old building was the suggestion of W. Cullen Morris, engineer of construction of the Consolidated Gas Co. The work has been under the super-

vision of the engineering department, Wm. H. Bradley, chief engineer. The particular manner in which the work was accomplished was developed by Herbert W. Alrich of the engineering staff. The girders were fabricated and erected by Milliken Bros., Inc., of New York City.

Robert Escobar

Robert Escobar, a pioneer iron and steel bridge designer and engineer, died May 20, in Havana, Cuba. Although of a retiring and modest disposition—never a member of an engineering society—his services in the early days of wrought-iron and steel bridge building are well known to a host of distinguished engineers, many of whom were his personal friends and associates for years.

He was a native of Cuba, of Spanish descent, born in Havana in 1837. After teaching school until he was 18 years of age, he came to the United States, where he entered Rensselaer Polytechnic Institute, graduating with honors in the class of 1857. Among his classmates were two other young men destined to reach high places in bridge engineering; they were Charles Macdonald, Past-President of the American Society of Civil Engineers, and Washington A. Roebling, who succeeded his father as Chief Engineer of the Brooklyn Bridge, New York.

Mr. Escobar remained in the United States after his graduation and for several years was associated with the Delaware Bridge Co., of which his friend and classmate, Charles Macdonald, was President. This company was very successful and built many famous bridges, including the Pennsylvania R.R. bridge over the Susquehanna River at Harrisburg, Penn., and the double-track bridge of the Morris & Essex R.R. over the Passaic River, New Jersey, with the design of which, and many more, Mr. Escobar was intimately connected.

When the Delaware Bridge Co. was taken over, in 1884, by the Union Bridge Co., Mr. Escobar continued in the service of the latter company and was for many years its Chief Engineer, until in fact it was merged, in 1900, with the American Bridge Co. During all these years he continued his association with Mr. Macdonald, who was one of the leading partners. While with the Union Bridge Co., at Athens, Penn., Mr. Escobar had charge of the design of the Poughkeepsie Bridge over the Hudson River at Poughkeepsie, N. Y. Another of the company's notable structures was the Hawkesburg Bridge in New South Wales, Australia, a work which was awarded to the American firm in competition with engineering firms from all over the world.

During his long career as a bridge builder, Mr. Escobar was at one time or another associated with nearly all those men whose names will always be connected with the history of bridge building in America. For the past ten or twelve years he had retired from all active work and returned to spend his last years in the home of his childhood at Havana.

A Dynamite Explosion demolished the gelatin cartridge house of the Canadian Explosives, Ltd., at Beloeil, P. Q., Can., July 24, killing seven.

A Record Freight-Car Movement on the Pennsylvania R.R. is reported for July, 1913. The total number of cars moved is given as 180,113, which was a thousand a day above July, 1912.

An Explosion of 200 gal. of naphtha in the napp[illegible] house of the New England Dyeing & Cleaning Co., Malde[illegible]ss., on July 26, according to press dispatches, caused the [illegible] of 21 employees.

A Section of a Theater Floor Collapsed in Mar[illegible]ohio, July 26. According to press dispatches several hu[illegible] per-sons were shaken up, two being severely injured, [illegible] one section of the floor of the Airdome Theater dropped [illegible].

The Pearl Harbor Dry Dock, at Honolulu, the f[illegible]lation of which failed on Feb. 17, 1913, as noted in "En[illegible]ering News," Mar. 6, 1913, p. 485, is to be examined by Alf[illegible] Noble, Past-President, Am. Soc. C. E., under a special co[illegible]mission from the Government. Mr. Noble will leave for Haw[illegible] early in August.

An Articulated Street Car of the type shown in "Engineering News," May 1, 1913, has been put in service by the Virginia Railway & Power Co. of Richmond. Two 21-ft. cars were put end to end with one platform on each removed by a center vestibule section. The car differs from the Boston type in that the floor is level throughout the combined unit and there is a continuous aisle; the car also is loaded and unloaded through the end platforms, there being no doors in the vestibule. The conductor takes his station at the rear end. It is reported that the rebuilt unit has a seating capacity of 64, and weighs about 45,000 lb.; the cost of rebuilding is about $800. Several others will be put out.

The First of the New Subways in New York City was opened for travel on Aug. 4. This is the so called Centre St. Loop line running now from under the new municipal building at Chambers St. and Park Row up Centre and Delancey Sts., about 1½ miles to the Williamsburg Bridge. Eventually this line will provide a loop connection between the three East River suspension bridges and will materially relieve the congestion at the Brooklyn Bridge, but at present it is being operated only as a continuation of the Williamsburg Bridge line and as a Manhattan terminus to one of the Brooklyn lines that has hitherto entered across the Brooklyn Bridge.

The loop was designed some years ago as an independent line, but was assigned to the Brooklyn Rapid Transit Co. in the recent adjustment of the lines of the dual subway system now under construction.

Suez Canal Traffic in 1912—The recent report of the Suez Canal Co. shows that the total receipts of the canal for 1912 were $27,005,068, an increase, when compared with the receipts for 1911, of $363,692. Expenses totaled $9,211,045, this sum including $579,000 charged off to depreciation and an equal amount to the fund for insurance and unforseen demands. The net receipts amounted to $17,794,023. Notwithstanding the reduction in the canal tariff the year 1912 was the most prosperous one the company has yet enjoyed. The maritime trade of the canal, in comparison with the preceding year, showed an increased value of 10⅛%, and the diminution in receipts, corresponding to the reduction in the tariff, was more than compensated by the general development of the traffic. During 1912 there passed through the canal 5373 ships of 20,275,130 net tons, a gain over 1911 of 404 ships and 1,950,326 tons. The average tonnage advanced from 3688 to 3774 tons. Notwithstanding the increased number and tonnage of the ships using the canal, the average time of transit was lowered during 1912 to 16 hr. 10 min., or 25 min. less than in the most favorable previous year.

Regulations Governing the Use of a Patented Material on New York State Road Construction—The 1913 legislature of New York included in the State Highway Laws recently enacted the following provision:

> In the construction, maintenance or repair of state or county highways no patented material or article, or any other material or article shall be specified, contracted for or purchased, except under such circumstances that there can be fair and reasonable opportunity for competition, the conditions to secure which shall be prescribed by the Commissioner of Highways.

On July 22, 1913, the State Highway Commissioner, John N. Carlisle, adopted the following rule, according to the requirements of the law, to regulate the acceptance of "bitulithic" pavements:

> Upon the owner of "bitulithic" pavement patents complying with the following requirements, the use of this pavement is permitted in the State of New York until further orders of the Commissioner:
>
> When the Commissioner determines that a pavement in any city or village on a county or state highway in the state of New York shall be constructed of "bitulithic" pavement, the owners of the patents of the said pavement, within five days thereafter, shall file with the State Highway Department, at Albany, N. Y., a price at which they will deliver the said material to contractors in connection with the said work to be constructed or improved. This price is to be available to any contractor desiring to bid on the work, and the provisions of the offer of the said company owning the patents are to be approved by the State Highway Department.

A 330-Ft. Reinforced-Concrete Arch is Being Built at Langwiez, Switzerland, on the Chur-Arosa railway line, a new section of the Rhätische Bahn (3.28-ft. gage). The arch will have about 160-ft. rise. It is to consist of two ribs, connected by struts, and carrying posts on which the beam-and-slab deck is supported. The ribs will have a thickness of about 4 ft. at the crown and about 14 ft. near the skewbacks. The abutments are to rest on rock, and one has been successfully founded and completed; the other is penetrating moraine deposits and has not yet reached rock. A noteworthy feature of the construction work is the use of reinforced concrete for the lower half of the centering. This part, comprising three trestle bents two stories high and their bracing, has been built. The main or middle part of the arch forms is to be carried by radial struts footing at the tops of the reinforced-concrete bents. The bridge is to be completed during the coming autumn. The contractor is Ed. Züblin & Co., of Strassburg, Germany. The bridge exceeds all existing reinforced-concrete arches in span, being slightly longer (about 2 ft.) and very much higher (130 ft.) than the Risorgimento arch over the Tiber at Rome, Italy.

The Heaviest Concentrated Rainfall ever recorded in New York City, occurred July 28. The total rainfall for the day was 3.11 in. at Central Park, and 0.62 in. at Battery Place. According to the United States Weather Bureau the heaviest rainfall previous to this occurred on July 10, 1905, when 2.74 in. of rain fell. A comparison of the amount of rainfall during equal periods of these two storms is given in the following table:

RAINFALL IN INCHES

Time, minutes	July 28, 1913 Central Park	July 28, 1913 17 Battery Place	July 10, 1905 100 Broadway
5	0.51	0.36	0.74
15	1.20	0.49	1.63
10	0.96	0.47	1.26
30	1.48	0.51	2.09
60	2.73	0.54	2.30
120	3.11	0.57	2.56
24 hr.	3.11	0.62	2.74

The rain of July 28 flooded many sections of the sewer system, causing much damage to property and business, the sub-floors of many buildings being inundated.

The Garbage-Disposal Problem in Chicago has reached an acute stage, as the present contract with the Chicago Reduction Co. expires on Aug. 31, and nothing has been done to provide means for disposal after that date. The matter has been under consideration by the city intermittently for a long time, brief periods of discussion alternating with long periods of neglect. Proposals have been asked at different times, but bids have been unsatisfactory for various reasons, and at the last occasion no bids were received. The company has offered to make a five-year renewal of its contract for $150,000 or a three-year renewal for $230,000, the city to supply 2,000,000 gal. of water daily without charge in either case. It has also offered to sell its property. The company has rejected the mayor's propositions for a two-year renewal of the contract or for a lease of the company's plant by the city. The latest development is that on July 23 the city's finance committee recommended that the city purchase the plant at an appraised valuation, and this plan will be submitted to the city council. Two days earlier a commission was appointed to investigate garbage disposal, as follows:

John A. Richert, chairman of the finance committee of the city council.
Dr. Willis O. Nance, chairman of the health committee of the council.
Dr. George B. Young, health commissioner.
L. E. McCann, commissioner of public works.
Col. Henry A. Allen, assistant city engineer.
Miss Mary McDowell, chairman of the city waste committee of the Woman's City Club.
Mrs. William B. Owen, corresponding secretary of the Woman's City Club.

Single-Phase Electric-Traction has been fixed on for the Bluefield-Vivian section of the Norfolk & Western Ry., general plans for which were given in "Engineering News," June 12, 1913. The consulting engineers of the road, Geo. Gibbs and E. R. Hill, of New York City, have made the following announcement:

A recommendation to adopt the single-phase system was made after an exhaustive analysis of the various systems now in use both in this country and abroad. A careful study was also made of the local conditions involved and comparisons made of the capital and operating costs, based on operating data and manufacturer's bids for equipment.

The intention is to use 25-cycle, single-phase current at a potential of 11,000 volts at the trolley. Power will be supplied from a power house to be erected by the railway company at Bluestone, W. Va., with an installed capacity of 27,000 kw. For transmission purposes the potential will be raised to 33,000 volts, and the transmission line will be carried mainly on the catenary bridges. Feeding points will be established at suitable locations along the line sufficiently close to minimize voltage drop and inductive disturbances.

In view of the fact that freight trains only are to be handled, the 24 locomotives are to be equipped with motors of the induction type, and the control and connections are to be arranged to give three running speeds of approximately 7, 14 and 26 mi. per hr., respectively. Special attention is being given to the question of regeneration and electric braking on grades, which would decrease the wear and tear on train equipment and also under favorable conditions tend to reduce the demand on the power house.

The Express Rates of the entire country are revised in a decision of the Interstate Commerce Commission announced Aug. 4. Two years' trial is imposed of a system of rate schedules according to geographical blocks applying to all companies and to all parts of the country. This involves the publication of a joint directory showing the location, by blocks, and sub-blocks, of all towns served and the call and delivery limits. Rates for adjacent blocks are computed between the sub-blocks; for longer hauls only main blocks are considered. A more uniform classification of shipments are made than has existed. In general all matter is divided between "Class One" (general merchandise) and "Class Two" (articles of food and drink). A few certain specified articles, more liable to damage or more troublesome to handle, have the first-class rates multiplied up to eight times. "Class Two" rates are not to exceed 75% those for shipments as first class, with a minimum of 25c. Third-class rates are established at 1c. for each 2 oz. or fraction thereof (with a 15c. minimum) until first-class rates are reached. Two or more packages forwarded simultaneously to one consignee are to have their weight aggregated, except when the average drops below 10 lb., when each bears the 10-lb. rate. There are also imposed revised rules and regulations of the companies, new forms of receipts, labels, etc.

The reductions bear hardest upon long-haul rates and on general merchandise. It is estimated that an average reduction of rates of 15.3% will result, aggregating some $26,000,000 per year. The order goes into effect Oct. 15, unless successfully combated by the companies.

PERSONALS

Mr. A. C. Bell has resigned as Engineer of the Board of Commissioners of the Port of New Orleans, La.

Mr. W. T. Leyden, Master Mechanic of the Minneapolis & St. Louis R.R., at Marshalltown, Iowa, has resigned.

Mr. Charles F. Puff, formerly Registrar of the Bureau of Surveys, Philadelphia, Penn., has been appointed District Surveyor at a salary of $4000 per annum.

Mr. J. M. Robinson, recently District Manager of the International Harvester Co of America, has been appointed Sales Manager of the M. Rumely Co., LaPorte, Ind.

Mr. W. C. Groening, formerly Shop Superintendent of the Pere Marquette R.R., at Wyoming, Mich., has been promoted to be Master Mechanic at Wyoming, succeeding Mr. J. E. Hickey, resigned.

Mr. T. J. Hayes, Trainmaster of the Cleveland division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Cleveland, Ohio, has been promoted to be Superintendent of Terminals at Cincinnati, Ohio.

Col. George Washington Goethals, M. Am. Soc. C. E., Corps of Engineers, U. S. A., Chief Engineer of the Panama Canal and Chairman of the Isthmian Canal Commission, has accepted the Honorary Presidency of the International Engineering Congress to be held in connection with the Panama-Pacific Exposition at San Francisco, Calif., Sept. 20-25, 1915.

Mr. H. P. Letton, Jun. Am. Soc. C. E., Field Assistant, Division of Food, Drugs, Water and Sewerage, New Jersey State Board of Health, where he has been engaged in the supervision and inspection of the water supplies of New Jersey, has been appointed Sanitary Engineer with the United States Public Health Service, and is at present engaged in a sanitary survey of the Potomac River.

Brig.-Gen. William H. Bixby, M. Am. Soc. C. E., Chief Engineer, U. S. A., has asked to be retired on Aug. 11, to make possible the appointment of his classmate and lifelong friend, Col. W. T. Rossell, senior Colonel, Corps of Engineers, U. S. A., now in charge of the Third New York District at New York City. Gen. Bixby would not retire automatically under the service laws until Dec. 27, 1913, while Col. Rossell will retire on Oct. 11, 1913.

Mrs. Edith W. Pierce has been appointed an Inspector of Street Cleaning, Bureau of Highways, Philadelphia, Penn., being the first woman to hold that office. The salary is $1200 per annum. Mrs. Pierce is quoted by the Philadelphia "Public Ledger" as follows:

I shall endeavor to gather a band of volunteer workers to get cleaner streets for Philadelphia. I shall also do every-

thing in my power to insure the rigid enforcement of the ordinances relating to the throwing of garbage or litter of any kind into the street. Another important feature is the battle against dust. Street dust, which is composed in great measure of dirt swept from homes and other buildings, carries disease germs. The streets should be sprinkled more frequently.

Mr. Charles F. Marvin, Meteorologist of the United States Weather Bureau, has been appointed Chief of the Bureau, succeeding Dr. W. L. Moore, removed a short time ago. Mr. Marvin graduated in mechanical engineering from Ohio State University in 1883. For the succeeding four years he was an instructor in mechanical drawing and in mechanical and physical laboratory practice. In 1884 he received an appointment on the civilian corps of the signal service and later was made Professor of Meteorology of the U. S. Weather Bureau. He has made important investigations of anemometers for the measurement of wind velocities and pressures and has invented instruments for measuring and automatically recording rainfall, snowfall, sunshine, atmospheric pressure, evaporation, etc.

Messrs. William J. Barney, Assoc. M. Am. Soc. C. E., former Second Deputy Commissioner of the Department of Docks and Ferries, New York City, and Philip B. Kennedy, Instructor in trade and transportation at New York University, have been engaged by the Merchants Association of New York City to gather information with regard to the proposed establishment of a free port in New York. The proposal contemplates the creation of an area or zone into which merchandise may be imported without paying tariff charges. Prof. Kennedy sailed recently for Europe for the purpose of studying the economic, commercial and industrial aspects of free ports. Mr. Barney has studied European ports with special reference to port administration and harbor engineering. He is to prepare a report on the administration of the harbor, with detailed information regarding harbor organization at the principal ports of the world. His study will be made with especial reference as to whether the establishment of a free port at New York would present difficult problems; and he is to prepare plans with an estimate of costs.

OBITUARY

John Milne, eminent seismologist and known all over the world for his earthquake investigations, died July 31, at Newport, Isle of Wight, England. He was born at Liverpool, England, in 1850. His education was received at King's College and the Royal School of Mines, at London. His first scientific experience was as Mining Engineer for Cyrus Field, Sir James Anderson and others in Newfoundland and Labrador. Later he was Geologist of Dr. Beke's expedition into Northwest Arabia. For 20 years he was employed by the Japanese Government as Geologist and Mining Engineer. It was during his service in Japan that he became interested in seismology and established the Seismic Survey of Japan, embracing 968 stations. Later he established a seismic survey embracing the whole world, supported by the International Association of Seismology. He was the designer of our modern seismographs and instruments to record vibrations on railways, etc., and the author of several books on seismology, geology, mineralogy and mining.

Alonzo Tyler Mosman, M. Am. Soc. C. E., Assistant, United States Coast & Geodetic Survey, Washington, D. C., died at his home in that city, June 9. He was born at Stoughton, Mass., Feb. 5, 1835; graduated from the Sheffield Scientific School, Yale University, in 1854; and after serving his alma mater as Instructor of Engineering for two years, he entered the Coast Survey June 1, 1856.

Soon after he was chosen to assist the distinguished astronomer, Dr. B. A. Gould, at Cambridge, and at Dudley Observatory, Albany, in making astronomical observations for the purposes of the Survey. He was sent to the Pacific Coast in 1859, and in the following year he observed the eclipse of the sun with Lieut. J. M. Gilliss, U. S. N., at Steilacoom, Wash., but the exigencies of the Civil War brought Mr. Mosman back to the Atlantic seaboard. In 1862 he was attached to a party making a survey of the Florida Reefs, for which duty the armed steamer "Vixen" and the schooner "Hall" had been assigned with directions to coöperate in any military operations that might be undertaken against the Confederates who were in possession of the mainland of Florida.

In 1863, he served under the Chief Engineer of the Military Department of West Virginia for the purpose of making a map for military purposes. In this case, as in many others, the duty performed by him and other officers of the Coast Survey during the Civil War was of a most hazardous nature and was accomplished under the most trying circumstances. Working far beyond the military lines of defense, often exposed to the fire of the enemy and at imminent risk of death or capture, their assistance was of the utmost value to the Army and Navy, as was repeatedly testified by the commanding officers and fleet commanders. In 1864, under Admiral Lee, Mr. Mosman made a successful and dangerous reconnaissance on the Tennessee River for the purpose of mapping it and combining it with surveys then being made of the Ohio and Mississippi for the use of the Army and Navy. In 1867, he was engaged in determining astronomical positions in the newly acquired territory of Alaska.

Among various other important duties may be mentioned his connection with the first transatlantic longitude by cable, his station being at Valencia, Ireland; his service under Admiral Selfridge in explorations on the Isthmus of Darien and the investigation of a route for an interoceanic canal; his work in connection with the transcontinental triangulation; his duties as one of the U. S. Commissioners for remonumenting and surveying the land boundary between the United States and Mexico; and his supervision and direction of the geodetic survey of New York City and vicinity from 1903 to 1910.

This brief outline of his career conveys no adequate idea of his influence on the Coast Survey. His sturdy, strong and noble character was evidenced by the purity of his private and public life, which made him an example to his fellows. Able, versatile, and faithful to every trust and responsibility, he commanded the affection and respect of all who were associated with him during his long and distinguished career. At the time of his death he was the senior officer in length of service. He is survived by a widow, two sons and two daughters. [Contributed by O. H. Tittmann, Superintendent, U. S. Coast & Geodetic Survey, Washington, D. C.]

ENGINEERING SOCIETIES
COMING MEETINGS

INTERNATIONAL GEOLOGICAL CONGRESS.
Aug. 7-14. Twelfth annual session at Toronto, Ont. General Secy., R. W. Brock, Director of Geological Survey of Canada, Ottawa, Ont.

THE TRAVELING ENGINEERS' ASSOCIATION.
Aug. 12-16. Annual convention at Chicago, Ill. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

AMERICAN PEAT SOCIETY.
Aug. 18-20. Joint annual convention of the Canadian and American Peat Societies, at Montreal, Can. Secy., Julius Bordollo, Kingsbridge, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Aug. 18-21. Annual convention at Butte, Mont. Secy., Bradley Stoughton, 29 West 39th St., New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 19-22. Annual Convention at Watertown, N. Y. Secy., Clarence R. George, Houston, Tex.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Sept. 1-4. Annual convention at Cleveland, Ohio. Secy., J. D. Farasey, 37th St., Cleveland, Ohio.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Sept. 1-6. Annual convention at New York City. Secy., Jas. McFall, Roanoke, Va.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 8-12. Annual convention at Chicago, Ill. Secy., L. C. Ryan, Chicago and North Western Ry., Stirling, Ill.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 9-11. The 24th general meeting at Denver. Secy., Prof. Jos. W. Richards, Lehigh University, South Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 10-12. Annual convention at Philadelphia, Penn. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 9-13. Annual meeting at Colorado Springs, Colo. Secy., S. M. Guma, 755 Boyleston St., Boston.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 9-12. Annual convention at Ottawa, Ont. Secy., A. P. Dane, Reading, Mass.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Sept. 17-18. Tenth annual meeting at Cleveland, Ohio. Secy., W. P. Blair, 824 Engineers' Building, Cleveland, Ohio.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 22-26. Annual Convention at Pittsburgh, Penn. Secy., I. D. Israel, 29 W. 39th St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 22-24. Annual meeting at Pitsburgh, Penn. Chairman, H. M. Wilson, 40th and Butler Sts., Pittsburgh, Penn.